JANUARY 19, 1959 Price 30 cents

DESIGN issue

Product Engineering

McGRAW-HILL MAGAZINE OF DESIGN
RESEARCH AND DEVELOPMENT

Columbia sails on rails . . .

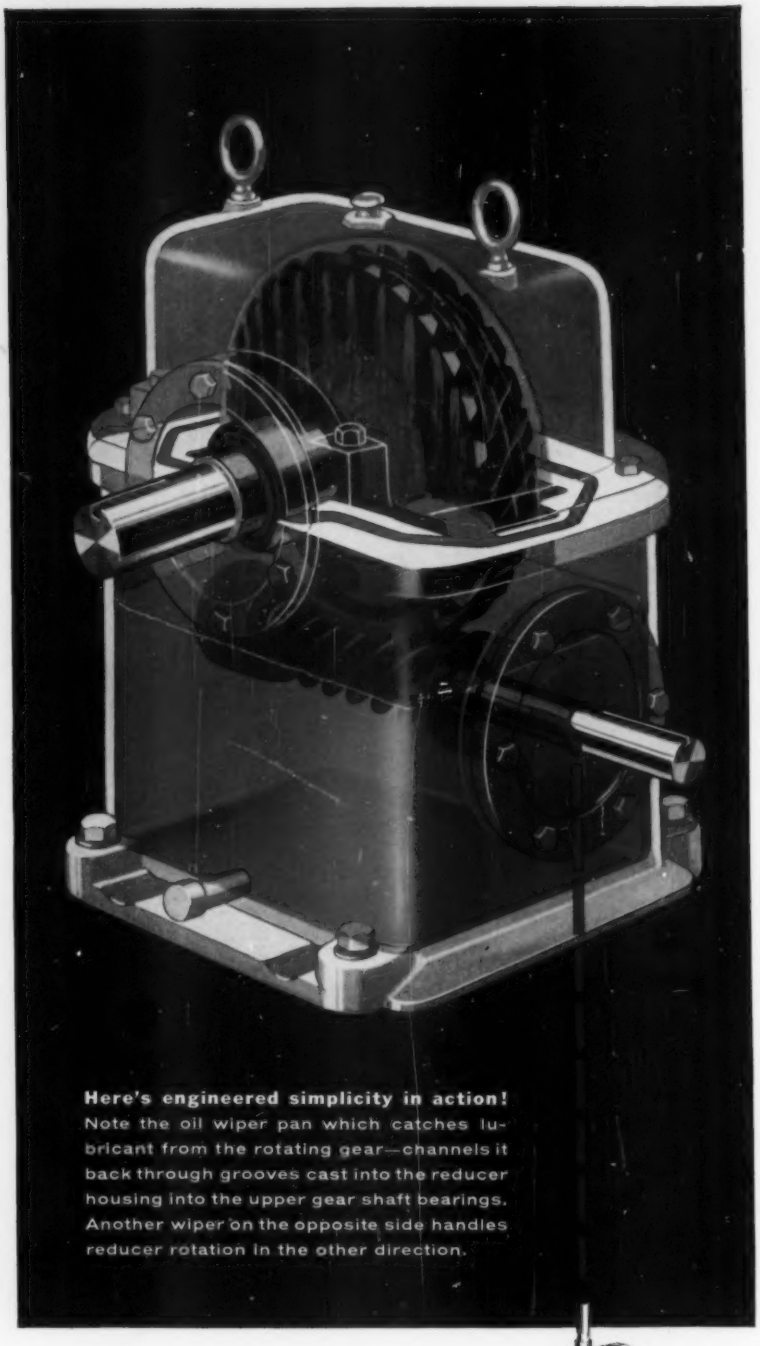
see page 5

Automatic, built-in lubrication helps give Clevelands their long service life

Here's one reason why many Cleveland Worm Gear Speed Reducers have provided trouble-free operation day in-day out for over 42 years.

The secret is continuing, adequate lubrication of Cleveland's case-hardened steel worms meshing with low-friction bronze gears. If reservoir is kept filled with good, clean oil, lubrication can never fail.

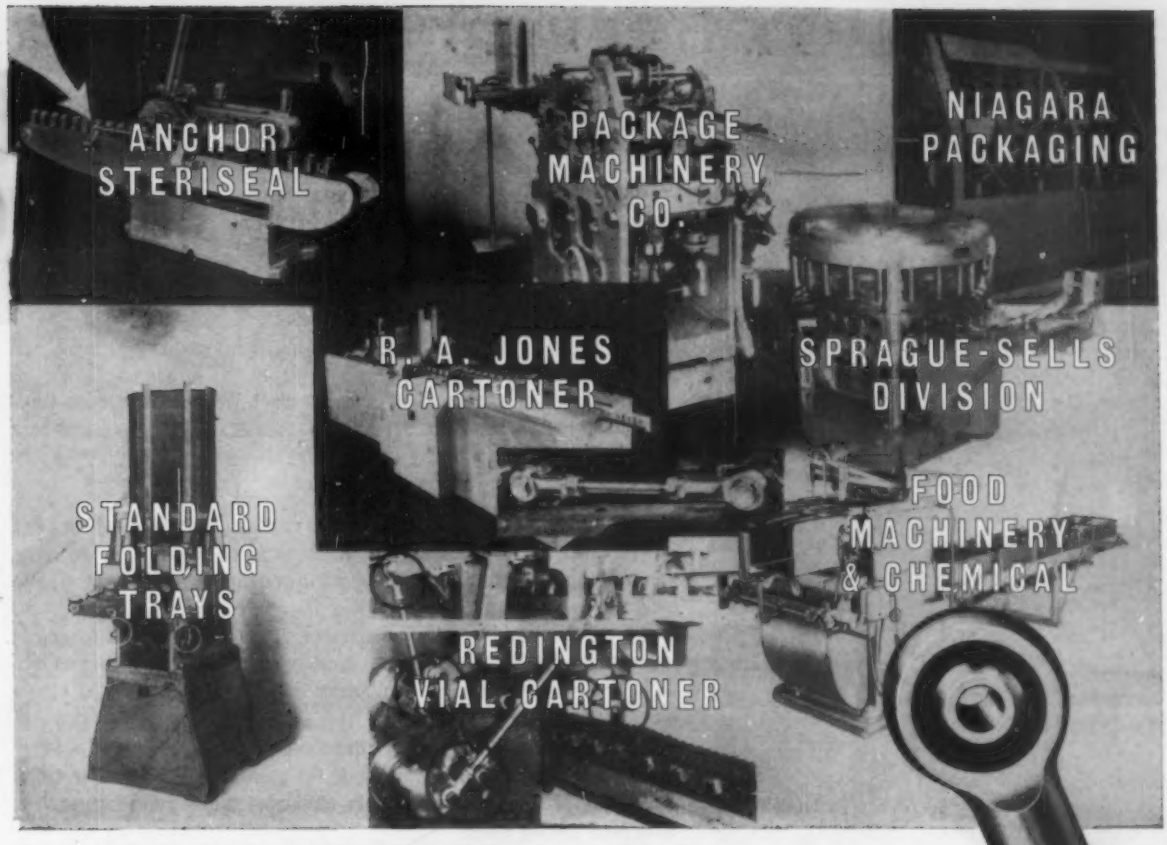
To get the complete "Cleveland Story", ask for your free copy of our new Bulletin 145. The Cleveland Worm & Gear Company, 3279 East 80th Street, Cleveland 4, Ohio.



Here's engineered simplicity in action! Note the oil wiper pan which catches lubricant from the rotating gear—channels it back through grooves cast into the reducer housing into the upper gear shaft bearings. Another wiper on the opposite side handles reducer rotation in the other direction.

Affiliate: The Farval Corporation, Centralized Systems of Lubrication. In Canada: Peacock Brothers Limited.

CLEVELAND
Worm Gear
Speed Reducers



Manufacturers of Packaging Machinery specify . . . .

HEIM *Unibal* SPHERICAL BEARINGS AND ROD ENDS

Cartoning machines fold package inserts and assemble them with the bottle or vial, insert them in a carton and deliver the finished package ready for shipment.

Rotary Fillers draw liquid or semi-liquid materials into a cylinder and discharge them, in accurately measured amounts, into containers.

Casers assemble a load of cans, and insert the load into a case — at unusually high speeds.

The Steriseal machine is used for high production steam vacuum sealing of glass containers.

Bottles, jars, tubes, and a variety of articles are fed from the labeling machine to the cartoner which opens the folding box, inserts the contents, then tucks and delivers the complete package.

The Cigar Wrapper-Bander cellophane wraps and bands cigars faster than two a second.

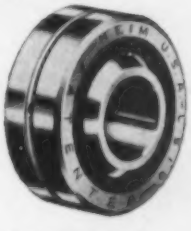
Folding trays, for tomato packaging and other types of fruits and vegetables, are formed from flat stock.

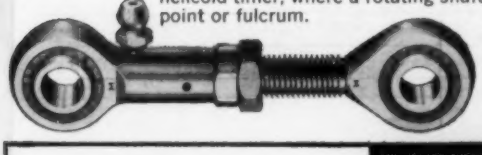
Imprinting of the package is done in one pass through some machines.

The motions involved in the push-pull linkages of this automated machinery are intricate and ingenious. Heim Unibal Spherical Bearing Rod Ends are used where it is necessary to correct inherent misalignments, and where close accuracy of fill and smooth operation at each station are mandatory.

They are used as suspended bearing supports for belt rollers. They change motion from vertical to horizontal plane, and vice versa.

The Unibal Spherical Bearing is exactly right as the support on one end of a helicoid timer, where a rotating shaft moving in all directions requires a focal point or fulcrum.





Quick and simple push-pull linkage assemblies are possible with one female threaded and one male threaded Unibal rod end. There is practically no limit to the length of linkages possible.

WRITE FOR CATALOG WHICH GIVES COMPLETE DATA, OR LET OUR ENGINEERING DEPARTMENT HELP WORK OUT DETAILS OF YOUR APPLICATIONS.

THE HEIM COMPANY

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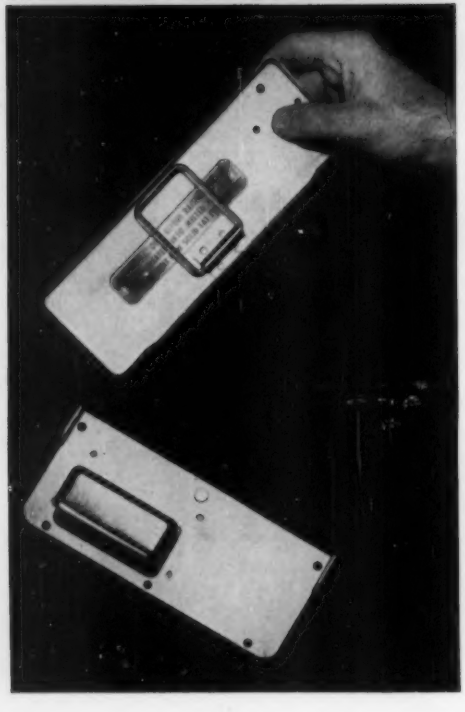

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With 4 Heat-Resisting Parts of Armco ALUMINIZED STEEL

Looking for a low-cost metal to "handle" high heat?

Read what Mr. J. Jarmuth, Plant Superintendent, Wells Manufacturing Company, San Francisco, says about Armco ALUMINIZED STEEL Type 1 and cost savings in commercial frying units:

"Every item in our Counter-Mate line contains ALUMINIZED STEEL. Its advantages in high-heat applications are obvious, but we have been able to obtain equally important benefits from the cost standpoint.

"Neither plated nor baked enamel parts on concealed or semi-concealed details of our units have been completely satisfactory. Both have been far more expensive than ALUMINIZED STEEL.

"For example, on our F-77 double fryer we have improved the durability of the product by switching to ALUMINIZED STEEL for control box backs and bottoms, shell bases, and outlet boxes. At the same time, we have effected a net saving of $2.50 a unit and have eliminated the coordination problem with local plating shops.

"As we become more and more familiar with fabricating techniques in forming, drawing, and spot-welding ALUMINIZED STEEL, we are expanding our use and are confident that it is a major factor in the successful quest for a better product at lower cost."

Perhaps Armco ALUMINIZED STEEL is a low-cost answer for heat-resisting parts of your product. Fill in and mail coupon for complete information.

New steels are born at Armco

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Product Engineering

THE McGRAW-HILL MAGAZINE OF DESIGN, RESEARCH AND DEVELOPMENT

JANUARY 19, 1959 Vol. 30, No. 3

5 Steps to Faster Reading 21... The Reading Laboratory Inc
Why take time to read through an article twice? This third in a series of 6 articles teaches you the art of pre-reading . . . so you can tell in a hurry whether the article is worth your time.

SPECIAL REPORT **What Do the Russians Weld With? ✻ 64...** Peter Trippe, London
Latest Soviet techniques, reported by this British technical journalist and appraised by three US experts, include: electro-slag welding for ultrathick sections; portable submerged-arc welders for confined spaces; stored-energy spotwelders for delicate assemblies.

Roll Cams—Stop and Go on Demand ✻ 68... A C Dunk, Purdue University
Graphical method for designing simple mechanisms that give a prescribed motion when triggered. Author works out two examples from industry—a record changer and an electronic typewriter.

Design Features in New Products 72... Grinder quickly redesigned with better looking, lower cost base; molding sped by revolving drum while extruder homogenizes the material; extra piston in hydraulic cylinder allows adjusting tractor tools on the move; custom drillheads from stock parts—castings go together like a watch case.

SPECIAL REPORT **Which Fhp Motor for the Job? ✻ 76...** N L Morgan, General Electric Co
A simpler way to pin down the right electric motor. First, know the basics of how the different candidates work. Then let application and cost guide you to the best answer in charts supplied by the author.

With Research Equipment: Safety First 82... J W Reid, General Electric Co
There's risk in apparatus for researchers who explore the unknown. Here are steps that will put safeguards where needed; also a case history showing how it paid to test a prototype.

DESIGN FILE **12 Expanding and Contracting Devices 88...** Federico Strasser, Mankowitz & Strasser
Parallel bars, telescoping slides and other mechanisms that can spark answers to many design problems.

Gear-tooth Index Error 91... H R Ronan Jr, Gould & Eberhardt Inc
Handy chart converts linear to angular error.

Helical-spring Design Chart 93... Charles Tiplitz, Chalon Consulting Engineers
Gives quick answers for steel springs.

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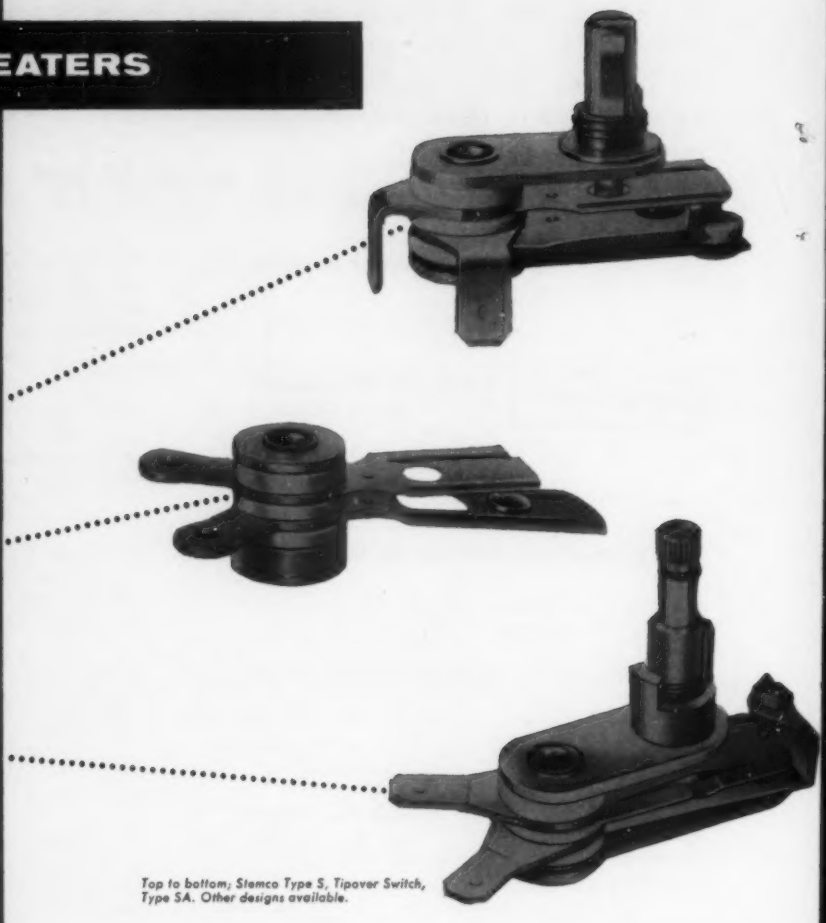
FOR PORTABLE AIR HEATERS



Top to bottom; Stemco Type S, Tipover Switch, Type SA. Other designs available.

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No wonder leading manufacturers of portable air heaters specify Stemco thermostats. For Stemco thermostats give long-life reliability that eliminates service headaches . . . are quickly, easily installed . . . are competitively priced. Our application engineering service is eager to help you solve your thermostatic control problem, whether it involves design, production or cost. Try us *now*. AA-9041

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THERMOSTATS

Other appliances, too, such as automatic coffee makers, skillets, saucepans, griddles, inhalers, fans, steam and flat irons, roasters, fry kettles, refrigerators, butter warmers, waffle irons, electronic and avionic applications.

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Interesting to Note . . .

Columbia—the Gem of Disney's Ocean

Shortly after the birth of our nation, less than 200 years ago, a group of Boston merchants led by architect Charles Bulfinch decided to send a ship around the world. For America, this was to be a first. We were not a seafaring nation but needed to open our own world trade routes—and what more dramatic way could be found?

So, on Sept. 30, 1787, the Columbia set sail from Boston Harbor. She sailed to the Hawaiian and Sandwich Islands, then to China, establishing contacts for fur trade with the Orient. When she returned home, 34 months later, the Columbia had traveled 41,899 miles. On her next voyage, Robert Gray, her captain, discovered the river in the Pacific Northwest which now bears the ship's name.

The Columbia shown on our cover is the Walt Disney version on display at Disneyland. Built at a cost of $300,000, the 137-ft ship is an exact duplicate of Gray's vessel from waterline up—even to the same number of cannon. But below waterline—what a difference! Disney's ship runs on a track laid under the surface of a lagoon in Disneyland. Two propellers are driven by two 15-hp 240-v shunt-wound GE motors. They are coupled to Western Gear Corp gear reducers with 4.15 ratio. Twenty-two tons of storage batteries in the hold supply the ship's power. They're recharged at night when Disneyland is closed.

Westinghouse—Current Champion

Soon after Edison electrified the country with a demonstration of his artificial source of light, he established the Edison Electric Lighting Co to sell direct current to those interested in having electricity for their homes or offices. In large cities, handling dc was not too great a problem. Although generators did not lend themselves to large capacities, the source of electrical demand was near enough the power stations to make relay depots needless. In rural areas, it was a different story. Farmers who considered giving up oil and kerosene in favor of electricity had to figure in the cost of adding relay stations between the generator and the farm.

One of the first to realize such difficulties of dc was George Westinghouse, a man known at the time not for his electrical endeavors but for invention of the air brake. In 1883, Westinghouse assembled a staff and studied various methods of electrical transmission. It soon became obvious to the Westinghouse group

(Continued on page 7)

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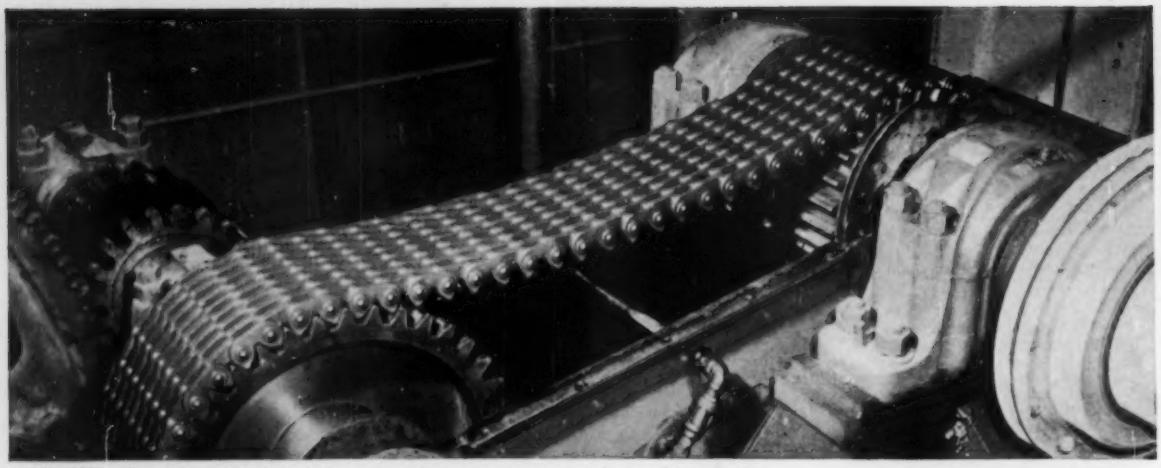

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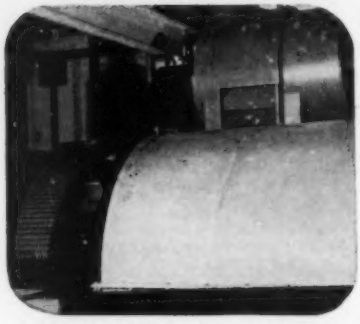
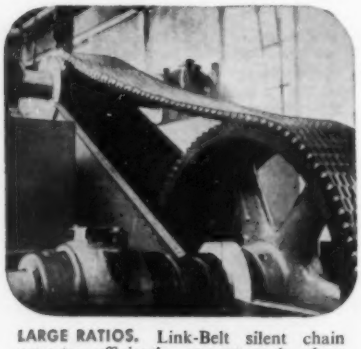
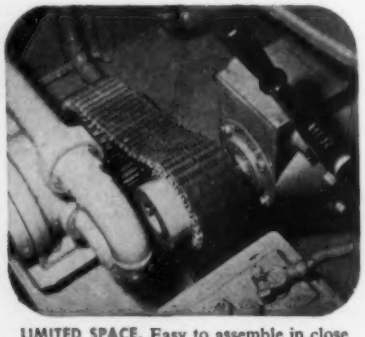


LARGE OR SMALL HP. On a 300 hp drive like this or at fractional hp, silent chain is always lower in ultimate cost.

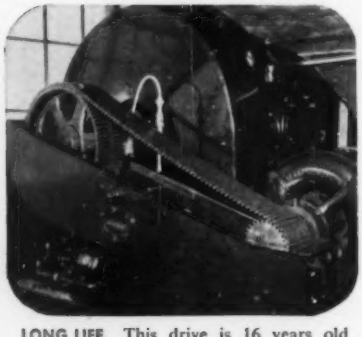


LARGE RATIOS. Link-Belt silent chain operates efficiently on extremely short centers at ratios as high as 10-to-1.

ADVERSE OPERATING CONDITIONS. Heat, humidity and cold have little effect on Link-Belt silent chain drive performance.

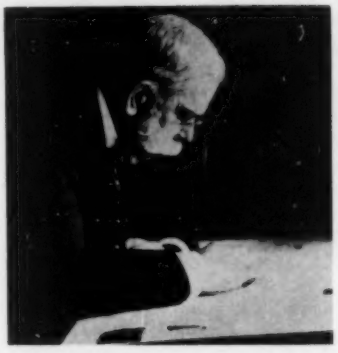


LIMITED SPACE. Easy to assemble in close quarters, Link-Belt silent chain permits built-in drives, compact housings.



LONG LIFE. This drive is 16 years old and still going strong. Not unusual—many others have lasted twice that long.

that alternating current had many more advantages than the existing direct current being supplied by most generators. It had its disadvantages too—light of the ac arc lamp was from the incandescent tip of the carbons while the dc arc lamp glowed throughout the entire carbon. (This was corrected in later years.) Furthermore, the noise of these early ac arc lamps was most objectionable.



Westinghouse loathed having his picture taken. This snapshot was taken with a camera concealed in his E. Pittsburgh laboratory by his employes.

Westinghouse and his group carefully weighed both ac and dc. They studied the works of Pantaleons, Gaulard and Gibbs who were pioneering ac in Europe, then they decided to bring Gaulard to Pittsburgh. The result of his visit was the design of a practical transformer that made possible the transmission of high-voltage alternating current over long distances. In 1885, the Westinghouse Electric Co was established with 27 patents relating to the electrical art and a capitalization of one million dollars. These patents were to be the company's life's blood.

No sooner was it learned that a new company was established to champion ac than opposition arose. The most learned sources joined in denouncing ac. This rebuttal only incensed George Westinghouse to work harder to prove he was right.

In 1892 the Westinghouse Co had its chance to prove itself. It underbid the Edison General Electric Co on the contract to light the Columbian Exposition in Chicago the following May. Never before would so much artificial light be produced in one place. The Edison group, with direct current, realized what was in the offing should ac prove better and cheaper. Since Edison held the patents for the carbon-filament glass globe, he could get a court order restraining Westinghouse from using them. This he did, leaving Westinghouse holding two wires but no bulb. Before the fair opened, however, Westinghouse developed a lamp in which the wires were mounted on a "stopper" inserted in the globe and the opening sealed as the air in the globe was exhausted. The court held this bulb didn't infringe Edison's patent. Unfortunately, these "stopper lamps" burned out very rapidly, necessitating constant replacement. But alternating current proved its superiority. Now, 65 years later, the electrical power that reaches motors (page 76) for home and industry is ac all the way.

Got a Match?

Radios tumbling into bathtubs, children crawling into old, discarded refrigerators, women falling asleep under sun lamps—such are frustrating examples of how a simple, easy-to-use product can be a death trap. Designing safe products, p. 82, is often complicated and expensive. When the Model T started pushing horses off the road, many a man sported a cast on his arm resulting from the pesky hand-crank. Firearms, early gas and kerosene stoves, steam engines and other implements employing fire have been responsible for a long list of accidental deaths. Through the years fire has been responsible for more accidental deaths than any other source. However, the automobile is rapidly catching up; in less than 50 years, cars have been responsible for taking more than 1¼ million lives.

One cause of fires in the past was the simple act of lighting a match. Safety matches only came into existence 60 years ago; before that we had a wide selection of fire-starting implements. During the 18th century there were phosphorous-tipped wax tapers enclosed in small glass tubes-to start a fire, simply break the glass. Earliest type of self-igniting match that didn't contain phosphorous appeared in France around 1805. To obtain a flame, a wooden stick tipped with potassium chlorate and sugar was immersed in a small phial of sulphuric acid. White-phosphorous matches came into prominence around 1840. Though easy to use, they were the most dangerous. Besides causing unwanted fires the phosphorous inflicted workers in match factories with an agonizing necrosis of the jaw-bone. Matches are now being overshadowed by the pocket lighter, perhaps the safest fire source of all.

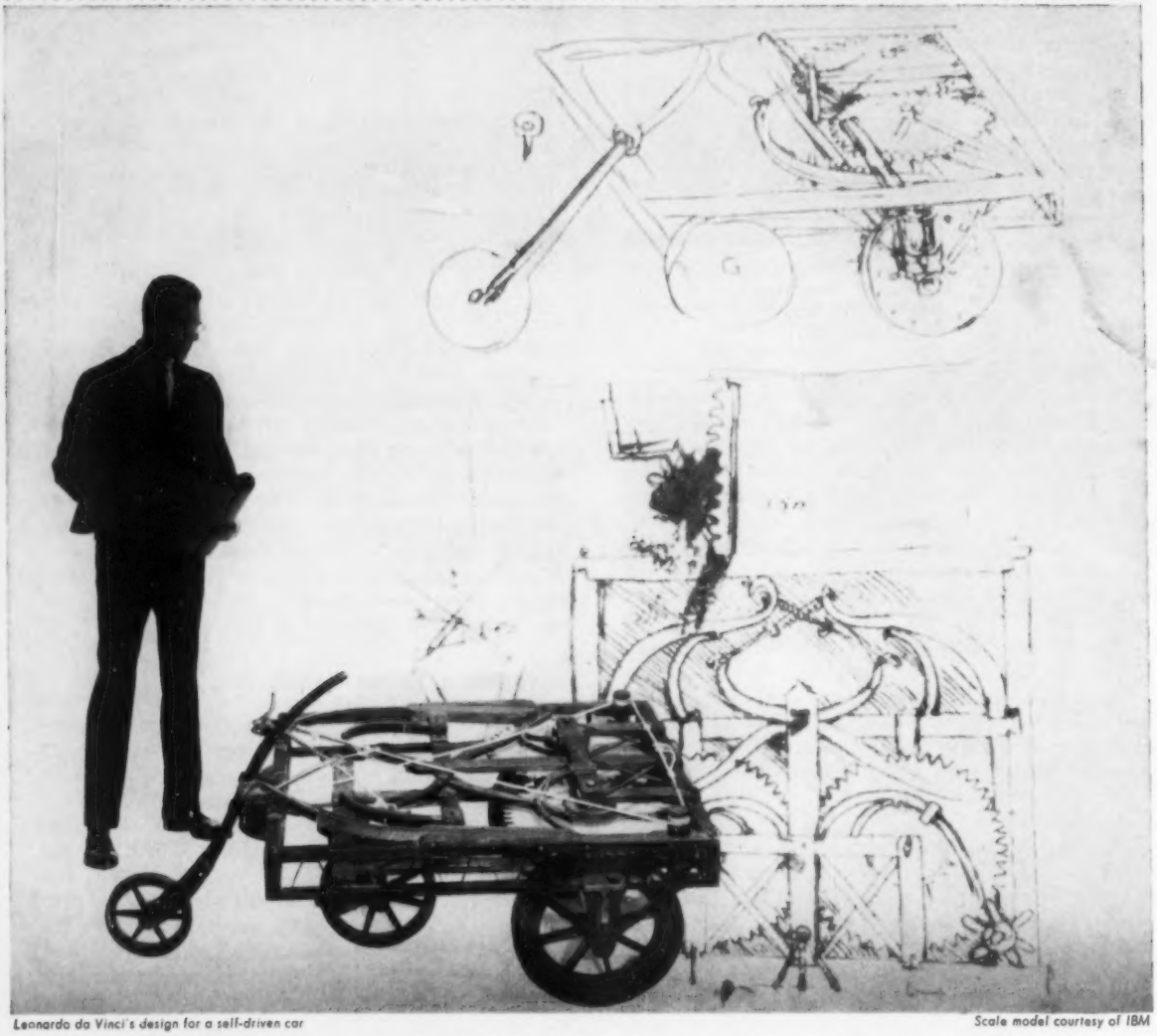
Get a Horse—Before It's Too Late

The mule residing at West Point is now the only hay-fed GI left in the Army. Only recently all other mules were sold when the Army felt their usefulness not worth the cost of their upkeep. Since the year 1924, when the country supported 23.3 million mules and horses, the equine population has steadily fallen. In 1956 the horse and mule population was a feeble 3.9 million, and many of these were paid for hauling a jockey rather than a plow. Obviously the tractor was responsible for the demise of old Dobbin. However, when Holt and Best were staging their big competitive battle for tractor sales in 1890 (*PE*—Aug. 18 '58, p 7) it appeared for some time that mechanized farm machinery would never take the horse's place.

Early tractor ads claimed the horse was out of step with progress. "His is the poorest engine ever built; for every hour he works, he eats 10 lb of food." It was figured that his thermal efficiency is only 2%. Some dealers tried to make tractor payments easier for prospective customers by offering to take mules and horses in trade. This worked quite well as far as sales went, but it gave the dealers the headache of feeding, housing and eventually selling the animals at a loss. Thanks to the tractor, the farmer now spends about 6 man-hours to grow an acre of wheat while his grandfather in 1830 spent 57 man-hours per acre. On page 74, a new device has been added to the tractor—saving still more time for the farmer when he plows, harrows, weeds, or furrows.

—Benedict A Leerburger Jr

creative designing calls for an open mind



Leonardo da Vinci's design for a self-driven car

Scale model courtesy of IBM

EVEN DA VINCI'S SELF-DRIVEN CAR COULD HAVE BEEN BETTER WITH HELP FROM AN SKF ENGINEER.

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Position Controls To Best Advantage by using S.S.WHITE remote control flexible shafts, as on this fractional horsepower variable speed electric motor. The shaft transmits changes in the setting of the control handle to the motor to allow exact speed changes while motor is in operation. It eliminates alignment problems, reduces number of parts required, saves time and cost in assembly and is adaptable to any number of special motor applications.

Key To universal flexibility of this handy drill unit is a ¼" S.S.WHITE flexible coupling shaft with drill collet attached. Use of the flexible shaft coupling makes unit compact, light and easy to handle. Coupling shafts – flexible shafts without companion casings – meet a wide variety of control and power drive applications. (Dept. 14)

Useful data on how to select and apply flexible shafts! Write for Bulletin 5601.

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Aluminum screw machine knobs — economical and versatile for your high quality products — offer designers infinite control panel styling possibilities both for shape and for color.

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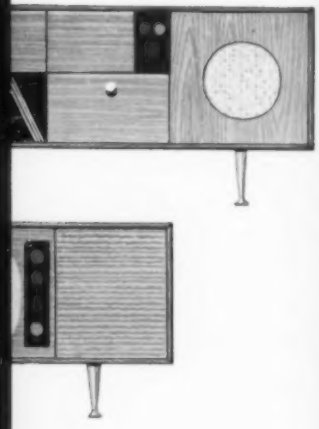

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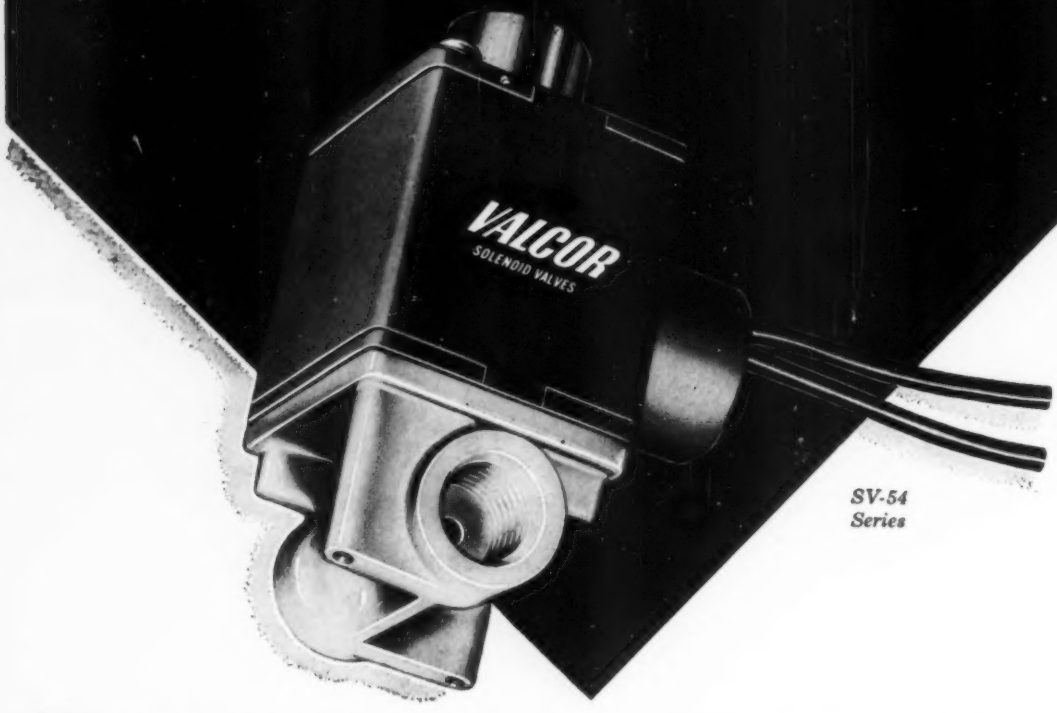
List Priced as Low as $10.75...

(Quantity Discounts Available)

Outlasts, Outperforms Steel!



SV-54 Series

VALCOR'S new 3-way Nylon solenoid valve, SV-54 Series, outlasts and outperforms steel, yet is list priced as low as $10.75! In general purpose and O.E.M. installations, where millions of operating cycles are essential, this new Valcor valve not only works best but costs less.

Its nylon seat outlasts steel...its port threads outlast steel... pound for pound it's *3 times stronger than steel.* Dry seal threads, no compound is needed—and they won't loosen even under severe vibration. Nylon is non-corrosive so you have no atmospheric problems. And the stainless plunger is a reliable workhorse for millions of cycles. Bubble tight sealing. Available in normally open, normally closed and "directional control" configurations in all normal AC and DC voltages...1½" square x 3" long (valve illustrated).

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↑ CIRCLE 109 READER SERVICE CARD

DEVELOPMENTS

TO WATCH...

Scandium will be the next "new" metal . . .

. . . to get major R & D attention from Wright Air Development Command.

Standing next to titanium in the periodic table of elements, and just underneath aluminum, it shows similarities to both and is about midway between them in both melting point and density. Until now, though, it has been almost completely neglected, and is not even mentioned in many handbooks.

High price (the oxide costs $700 an ounce, and the metal itself is even more expensive) and lack of domestic sources (the two major suppliers have been Norway and Madagascar) help explain the lack of interest. But now small percentages of the element have been found in rare earth ores, and the increasing demand for these materials promises to make scandium considerably more available.

Coatings that break circuits . . .

. . . have been developed by Naval Ordnance Laboratory researchers as part of their search for new materials that will meet increasingly stringent temperature and pressure specifications.

These are frangible ceramic coatings developed to serve as interrupted-circuit fuses—to break an electrical circuit on impact and thus trigger an explosive charge.

NOL also reports that a stabilized zirconia coating, available commercially, can serve as protective coating for the stainless steel wire baskets that house ignition-charge grains. Says NOL: "Such a ceramic coating can extend the time for basket burn-through considerably and delay clogging of vent parts."

Other NOL ceramic projects:

. . . developing ceramic coatings for missile power units that can withstand burning propellants,

. . . devising materials and methods for thermal insulation of the piezoelectric crystal holders used on impact fuses,

. . . formulating a dielectric for use where insulating properties must be retained to 1900 F.

Lubes for LOX systems . . .

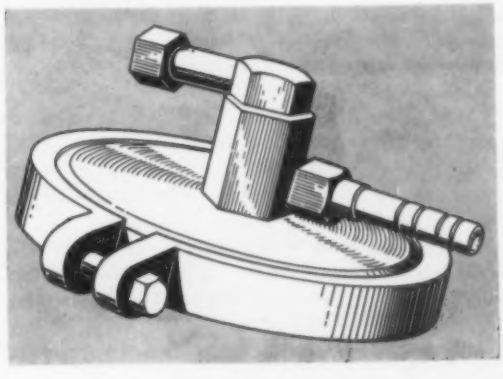
. . . are now coming from a number of sources, and aiming at commercial use in the many new devices that must operate at ultralow temperatures (*PE*—Dec 15, '58, p 5).

Maryland's Lehigh Chemical Co, for instance, announces a synthetic lubricant "with special antioxidant properties" found to be "completely safe with liquid oxygen no matter under what conditions it is used." Its number: X-1233.

Drilube Co of Glendale, Calif., offers "impact-insensitive" inorganic lubricants and thread sealants "completely unaffected by impact testing to 185 ft-lb in the presence of liquid oxygen." In addition, says Drilube, "they do not spall, flake, become brittle, or lose their adhesion when immersed in LOX under standard test conditions."

Gas-pressure equalizer . . .

. . . designed at Russia's United Acetylene Welding Research Institute, is a springless unit that combines a valve and diaphragm in such a way that "any change in the pressure of the gas on one side of the diaphragm affects the position of the valve, thus immediately adjusting the flow of the gas on the other side." It was devised particularly for oxyacetylene mixtures, but might be used wherever it is desired to control the flow of one gas in relation to the flow of another. In the oxyacetylene system, as described in an East German technical publication, the pressure equalizer feeds the gases to a mixing chamber in the torch, through calibrated nozzles mounted on the torch input.



DEVELOPMENTS

TO WATCH...

Drilling by vibration may be one answer . . .

. . . to the problem of probing the earth's core (*PE—Jan 12, p 14*), and might also pave the way for new designs in cutting tools. An investigation at Battelle Memorial Institute, specifically aimed at applying vibratory methods to deep-rock drilling shows that the newer technique may possibly be used as a supplement to, rather than solely as a replacement for, conventional equipment.

In one model, described at the last ASME meeting, vibrations (at about 300 cps) from a magnetostriction transducer are directly applied to a standard 10¼-in.-dia rotary bit as the transducer follows the bit down the drilling hole.

Advantages of the vibratory technique: Rate of penetration is much less affected by variations in the character of the material being drilled; and, in hard rock, at least, the rate can be stepped up considerably. In medium-hard rock and soft rock, though, this technique may not yet be able to pay its way.

Metal parts can be protected in tropical environments . . .

. . . by choosing the proper organic coating says Naval Research Lab; but no one type of coating will do the job under all conditions. NRL has tested more than 350 coatings systems over the past 6 years—alkyds, epoxies, synthetic rubbers, phenolics, vinyls—in marine and inland environments.

Test reports indicate that, for the most severe condition—mean-tide exposure—the vinyls and synthetic rubbers seem best, though none provided complete protection for much more than 3 yr. On parts completely immersed in sea water, coal-tar systems provided almost complete protection for periods as long as 6 yr.

In fresh water and inland air, all three types did well. Synthetic enamels based on alkyd and phenolic resins seem preferable for marine atmospheres.

New devices for heat control, wear measurement . . .

. . . chemical processing and quality control, can be developed by taking advantage of the ability of thin, vacuum-deposited films to pass or stop preselected wavelengths, says John R. Jennings, president of Spectracoat Inc, San Francisco.

There's nothing new about the idea, of course. Such vacuum-deposited films form the basis for many infrared optical devices—sniperscopes, aircraft temperature controls, warning systems. But, he points out, there is a whole spectrum of light, ranging over to the ultraviolet, waiting to be used. Too, most of the devices so far have been for military use. He believes "thin-film optics" can also pay their way in industrial processing and machine control.

Spectracoat, newly formed to explore and exploit these possibilities, will begin by concentrating its efforts in the infrared field; but plans soon to extend its research to other wavelengths; hopes to develop thin-film optical elements that can be applied to a variety of process control and testing instruments.

A low-temperature transformation that could cause trouble . . .

. . . is reported by J. E. Daub of Convair. It's a change in the structure of stainless steel, at liquid nitrogen temperatures, that results in a marked decrease in ductility.

Most studies, Daub says, "have shown that those [stainless] alloys containing significant [amounts of] austenite stabilizers, such as nickel, appear to be stable at temperatures of −320 F, the AISI types 321 and 347 in particular."

But Daub's tests of ½-in. type 321 bolts under tension in a liquid nitrogen bath showed that bolts—both as-received and annealed—fractured with less than 15% reduction in cross-section. Furthermore, though the area of fracture was only slightly magnetic after similar tests at room temperature, the nitrogen-cooled bolts were strongly magnetic along the entire shank.

This increase in magnetic properties seems to indicate, Daub says, that the metastable austenite is transforming to the less ductile martensite, a transformation confirmed by metallurgical examination.

As this transformation may result in a large reduction in ductility," he warns, "engineering applications of this alloy at temperatures of −320 F or below could result in failure."

More extensive tests are now being conducted to obtain additional data on the transformation and its possible effects. —ARG

Higher Engine Speeds Pose Truck Transmission Problems

DETROIT—Higher engine speeds for trucks, to get increased torque at running speeds, will require some means for preventing damage to gears during shifting, William Leonard of Clark Equipment Co told the annual meeting of the Society of Automotive Engineers here. Leonard limited his discussion to the counter-shaft type of transmission. In plotting the kinetic energy of a 13-in. clutch-driven disk against the engine speed, he showed that kinetic energy transferred to the gear teeth during a shift was about 1250 lb-ft at 2800 rpm. At 4000 rpm it jumped to 2600 lb-ft.

Synchronizers in the transmission are a mechanical answer, Leonard said, but they require constant-mesh gears mounted on some type of bearing.

In a typical 5-speed sliding gear transmission of an engine governed at 2800 rpm, relative speed between mainshaft and the constant-mesh third-speed gear is 1240 rpm. If the sliding second-speed gears are replaced with constant-mesh gears, the relative speed at same rpm input becomes 2160 rpm. With an engine governed at 4000 rpm, this relative speed is 3080 rpm—2½ times the worst condition encountered with the typical sliding-gear transmission.

Another modification provides pressure lubrication for mainshaft gear bearings, Leonard said. This includes an oil trough placed high on the wall of the transmission case to feed oil to a vane pump. This pump pushes oil down the center of the drive gear into the mainshaft and through holes of the gear bearings. Result is, oil level in the transmission and the subsequent internal heat is reduced. In the interest of further reducing heat, Leonard said, complete pressure lubrication will be necessary, replacing completely the splash system.

Increases in the power and speeds of engines are approaching the point where a new departure in drive-axle design will be required, N. R. Brownyer of Rockwell Standard Corp asserted. At present, truck engine speeds are being held to about 3600 rpm and require rear axle ratios of about 6.8 or 7.2 to 1. An increase of engine speed to 4000 rpm will require rear axle ratios of about 8.2 to 1. The industry will then have a choice of several ways to increase engine speed without increasing vehicle speed Brownyer said. These include:

- **Planetary reduction between flywheel and clutch to reduce clutch speed. This, however, increases torque input to clutch, transmisison, propeller shaft and rear axle.**
- **Planetary or spur gear reduction between clutch and transmission, again raising the problem of increased torque.**
- **Permanent underdrive in transmission by locking out direct drive, adding the speed to 3, 4, or 5-speed transmissions and increasing torque capacity for units back of the clutch.**
- **Planetary or spur gear reduction on back of transmission to slow propeller shaft without unnecessarily loading transmission.**
- **Spur gear reduction on nose of single reduction carrier. Shortened drive line geometry results from shortened propeller shaft in compact wheel base models.**
- **Single reduction carrier—possibly the most practical—with overhung pinion mounting. This construction copes well with heavy coast loads imposed by retarders and hand brakes.**

A third problem posed by higher engine speeds and greater torque is the additional load on clutch components. J. Robert Ludwig, Chief Engineer, Clutch Div, Dana Corp, asserts that solution to this problem lies in small, multiplate clutches.

Lab tests, he said, now indicate that an 11-in. 2-plate clutch will save 24½ lb when replacing a 14-in. single-plate clutch. An additional 12 lb is saved by removing the flywheel rim that served as mounting for the larger clutch. This also permits better cooling. Clutch disk moment of inertia with the multi-plate design was reduced 93 lb-in.^{2} and, because nearly ⅔ of the inertia to be overcome by synchronizers or double-clutched shifts comes from the clutch disk, a reduction in shift time is forthcoming.

SOLID-FILM LUBRICANTS ABOVE 1000 F

In a search for high-temperature solid-film lubricants for uses above 1000 F, R. E. Crump, Chief Engineer, Electrofilm Inc, said that equal parts of lead oxide and synthetic graphite give good characteristics. For a binder, a porcelain enamel was used, since the upper limit of resins is 600 to 700 F.

In tests at Electrofilm, a tapered roller bearing, 1⅜ in. OD, with a PbO-graphite solid film lubricant applied to the outer bearing surface was wear-life-tested at 72 rpm, at an ambient temperature of 1000 F for slightly over 40,000 cycles with a 630-lb load applied to a flat block rubbing tangentially to the shaft. Next best solid film lubricant tested (15,000 cycles) had equal parts of silver-lead oxide and graphite with a ceramic binder.

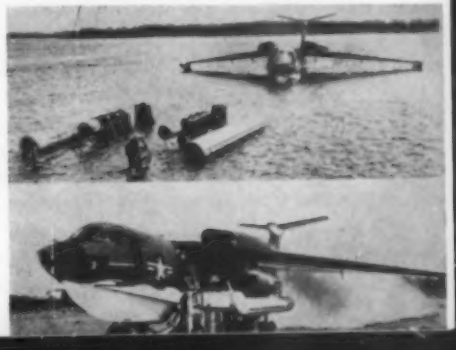
Another solid film lubricant, molybdenum disulphide, oxidizes above 800 F to trioxide, which is abrasive.

Product Planners on the Rise

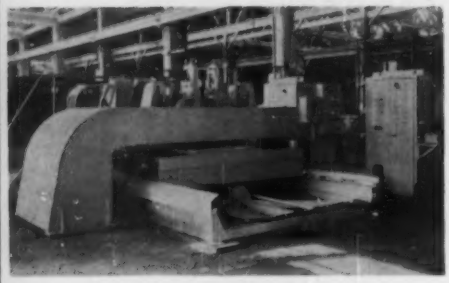
LOS ANGELES—The growing role of product planning in US industry was dramatized when Northrop Aircraft's Northrop Div elevated this activity to a division staff level. Formerly a portion of Weapon Systems Development Engineering Section, the product planning section (directed by C. Robert Gates of the Northrop Corporate Development Planning Staff) now reports directly to the division general manager.

Watery taxi stand . . .

waits for Navy's P6M Seamaster, then rolls the amphibious aircraft on to land. The beaching vehicle is equipped with Goodyear Terra-tires, and a hydraulic circulator pressure pack. The latter grasps the sides of the incoming plane's hull. Four jet engines then power the "sea taxi," and the aircraft riding it, on to the beach.



GE Redesigns 2 Machine Tools for Numerical Control



SCHENECTADY—Two new uses that General Electric has found for its numerical-positioning control system are a base plate driller (above, left), that has just been sent to GE's Industry Control Dept in Roanoke, Va, and a 20-ton punch press, still in the design stage (above, right), that will go to the Communications Products Dept, Lynchburg, Va. The base plate driller is of new design, while the punch press is an adaptation of existing machinery to the positioning control system. Design of both units to use NPC was by GE's Manufacturing Services Div here.

With the new driller, base plates of huge industrial electrical control panels are drilled automatically with a hole-to-hole accuracy of ±0.008 in. The equipment consists basically of two Burgmaster drillheads, a special compound positioning table, and the NPC system. According to GE, the machine can replace two or three manually operated drill presses, and eliminates all plate layout work.

Plates measuring up to 90 by 48 in. and as small as 12 x 12 in. can be handled by the positioning table. Maximum program positioning area of the table is 60 by 48 in. Average number of holes drilled per plate is 150; average drilling time per hold, including positioning, is 20 sec. There are some 3000 different hole patterns drilled in base plates in a year's time.

The two drillheads have a total of 12 spindles with drill sizes ranging from ¼ in. to 1 in. Usually 10 drills cover most sizes, but one of the extras is used for an indicator drill which tells the operator that a larger hole is to be drilled there. Another is for a centering drill for extra accuracy.

C. E. Warner, Head of the Advanced Equipment Development section of the Manufacturing Services Div, says major design problem was matching the selsyn gear train to the pitch of the positioning table's lead screw, because the lead screw's pitch was off.

PUNCH PRESS

While this is not the first application of NPC to the Wiedeman punch press by GE, (others are in the company's Utica, NY and Philadelphia plants) it is the first model to have an electrically driven positioning table. The others were hydraulically controlled. The system is also considered less complex. A new duplicate storage feature in the control system doubles output of the machine.

This new, temporary data-storage feature determines location of the next hole and size of the punch, then transfer this information into permanent storage while the previous operation is being made. Energizing the punching stroke simultaneously releases upcoming data from the temporary storage unit to permanent.

The punch press turret carries up to 20 punches in sizes up to a maximum of 1 in. Maximum workpiece dimensions are 10 in. by 20 in.; min size is 1 in. by 1 in.; max thickness is 3/16 in.; min thickness is 1/64 in. (the latter in small sheet size). Max hole density is 7 holes per sq in.

The magazine loader and clamps are electropneumatic with GE adapted automatic feed and clamping system. Table drive is electric. The frequent reversal of the motors caused a heat problem, but forced-draft convection cooling of the motor made possible a 50% increase in duty cycle. The drive of the positioning table uses recirculating ball bearings with no part of the drive mechanism exposed to the stress of the punching operation. Each table axis has a 24-in. travel.

Used on printed circuit boards and electronic circuit chassis, the press is expected to limit downtime with the new equipment. With a manually operated machine, normal utilization is 60%; with NPC it will be boosted to 90%, according to GE. Full-time machine operators will be eliminated. One part-time attendant will replace them at a net saving of about $10,000 a year. Templets will be eliminated, as will be the storage and loss due to breakage. GE expects to save about $5,000 a year here.

Adopting New Pound, Yard Standards

WASHINGTON—English-speaking nations will adopt new definitions for the yard and the pound by July 1 of this year. At present, each of three major English-speaking and inch-using countries—the US, Britain, and Canada—has a different measurement. (See also "Perspectives," Feb. 17 '58, p 61.) While these differences are so infinitesimal as to have little effect on daily transactions of most people, they are extremely important in the precise measurements required in many fields of science and technology.

CHANGES MADE

The new international yard equals 0.9144 meter. The new international inch, derived from the international yard, is 25.4 millimeters. The inch presently used here by the National Bureau of Standards is equal to 25.4000508 mm. The international inch is approximately 2 parts per million shorter than the inch now used by NBS, and somewhat less than 2 parts per million longer than the inch now used by the British National Physical Laboratory. To avoid possible confusion during the transition period, the NBS calibrations of length or mass expressed in English units will embody a statement indicating clearly the unit which has been used. The Coast and Geodetic Survey has permission to retain its American survey foot, since there is little exchange of survey data with industry.

The new international pound is equal to 0.45359237 kilogram, as compared with the presently used pound equal to 0.4535924277 kg.

Lubrication, Materials Problems in Space Vehicles Challenge Design Engineer

WASHINGTON—Lubrication for space vehicles, as well as the need for heat-resistant structural materials—pose big problems for design engineers, the nation's top space experts were told recently at the 5th Annual meeting of the American Astronautical Society here.

Most obvious solution to the lubrication problem would be to hermetically seal all motors and other moving parts, according to an engineering team from Airborne Instruments Lab, Div of Cutler-Hammer Inc. However, added weight would result; and the hermetic seal must be perfect too—otherwise, pressure in the vehicle would eventually pass through a region where continuous arcing will occur if voltages in excess of 350 volts peak are present. In addition, a hermetically sealed unit is difficult to service.

To avoid leakage, an alternative to a perfect hermetic seal would be a space vehicle equipped with a supply of gas. But this would be complex and add weight.

Use of solid lubricants has been suggested, but graphite is unsatisfactory in space. Reason: its lubrication depends on a monomolecular layer of water between tiny flat carbon plates. This water layer would disappear in a vacuum. Powdered molybdenum disulphide is said to be unsatisfactory when exposed to vacuum, while reinforced-Teflon sleeve bearings will probably be suitable where precise tolerances are not required, or where relatively high friction can be tolerated.

In general, use of solid lubricants is limited to sleeve bearings that have objectionable torque, and would require nonstandard motors. Bearings with silver-plate balls have been used in a vacuum, but are difficult to produce. Use of hard balls and races, such as sapphire or hard steel, running dry have been reported to result in short bearing life.

If an oil or grease can be found that will not evaporate in too short a time, conventional bearings will be used. A preliminary screening of lubricants by Airborne Instruments Lab has been completed at a pressure of 20 microns and 185 F. More tests are to follow at higher vacuum.

AND THEN MATERIALS

According to Peter E. Glaser of Arthur D Little Inc, structural materials capable of withstanding temperature conditions in space are needed. He added that since weight is of major importance, it is best to separate the load-carrying and heat-resisting elements of the vehicle and to assemble them in a composite structure. In such a structure, Glaser said, the load-carrying elements can be selected only for their mechanical properties, and the heat-resisting elements only for their thermal and chemical properties.

To help research this problem, an electric arc imaging furnace has been developed that is capable of generating temperatures to 4,000 K. Instrumentation has been developed, Glaser said, to use this furnace for measuring temperature and heat flux at surface of material.

Patent Pool Closes Canadian Market to US

OTTAWA—A Canadian patent pool has become the indirect target of US antitrust action. The district court of Southern New York has issued a complaint against three companies who do business in that state—General Electric, Westinghouse and N V Philips' Gloeilampenfarbrieken—and who operate Canadian subsidiaries that manufacture radios and TV sets. 12 other companies were named as co-conspirators, not defendants.)

These three companies, the court points out in its complaint, have turned over to their subsidiaries here the patents that the parent companies have acquired in Canada. The subsidiaries have pooled these patents in Canadian Radio Patents Ltd—a company that licenses them under package agreements to manufacturers of radio and TV equipment.

Crux of the US antitrust complaint is that members of the pool, which necessarily includes subsidiaries of US companies, have agreed not to import radio or TV sets if these include components that can be manufactured under CPRL patents. This agreement, the antitrust division asserts, closes the Canadian market to US manufacturers who do not have foreign subsidiaries. And the court interprets this as a conspiracy to restrain trade, a violation of the Sherman Act.

Under Canadian law, CPRL is legal and the US action has stirred some resentment here. Many Canadians say the US action is an attempt to dominate Canadian industry, or even worse, an attack on Canadian sovereignty.

Ian F. McRae, President of Canadian General Electric and a spokesman for the industry, has called the suit a "barefaced attempt to victimize certain US companies for business decisions taken, not by them, but by their Canadian subsidiaries."

The Canadian government so far has been silent. But a senior Justice Department official said he knows of no law or treaty under which Canada could protest the suit. The US can do what it chooses to companies under its jurisdiction, he said.

Simulate Entire Nuclear Power Plant

LONDON—A complete simulation system for a nuclear reactor power plant will be installed next July by Elliott Brothers of London at the 300-mw Berkeley nuclear power station. The equipment will serve as working model for a graphite-moderated, gas-cooled, natural-uranium-fueled reactor complete with the steam and power generation side of six boilers, multiple heat exchangers and blowers supplying two turbo-alternators on a dual pressure cycle. Main use will be for operator training, but the simulator can be extended at some later date for study of nuclear power plant control problems.

The simulator comprises three sections—the main control desk, the analog computer cabinets, and two wall-mounted boiler panels. On the control desk, in addition to the normal reactor controls for control rod positioning, are blower speed controls, turbine valve settings and boiler feedwater valve controls. Indicators and

recorders show reactor power level, power deviation from set point, doubling time, moderator temperature and generator loads.

For training purposes a set of instructor's controls allows variation of the reactor reactivity either gradually or as a step function, as well as tripping one or both generators, stopping one blower or simulating failure of the feedwater system.

Tape Control Offers Versatility

DETROIT—New feature of the Bendix numerical control system uses a code to identify different sections of a tape permitting automatic selections of different portions. The control for machining operations of different parts can be put on one tape, eliminating the need for changing tapes every time a new part is machined.

A variation of this system also breaks down long machining operations into more convenient subdivisions. Under normal operating conditions these subdivisions are not necessary and the whole machining operation is uninterrupted. But when the machine has to be stopped for some reason, such as tool breakage or the end of a shift, pressing a reset button brings the machining control back to the previous "reference point." This point is identified by visual display and machining is restarted from here.

Punched tape used with this system permits many punched-hole combinations. Some of the combinations are being used for auxiliary control functions, such as starting or stopping a spindle, turning coolant on or off, return to starting position. As many auxiliary functions as desired can be controlled, Bendix claims.

Russians Automating Their Bearing Plants

VIENNA—A 100% increase in output by 1965 for the USSR roller bearing industry has been predicted by the Soviets. They say it will be accomplished by greater automation. Seven types of complex transfer lines will be installed in Russian bearing plants.

Newly designed bearings will include some capable of 200,000 rpm (twice present rate), and others weighing up to 5 tons.

Air Clamping Cuts Machining Time

DALLAS—Conversion of a Keller 3-spindle profiling machine, with substitution of air clamping for manual clamping of heavy aircraft wing beams, saved Chance Vought Aircraft 40% in time required for the operation. The 200-lb forgings formerly were held in place for profiling by wrench-tightened clamps; now the job is done with a system of clamps operated by five air valves.

The 11-ft-long aluminum alloy forging is held in place by 17 of the air clamps. They are tightened or released by turning a hand valve, color-coded to match the clamps. The system allows the operator to move certain clamps to permit cutter travel without stopping the operation.

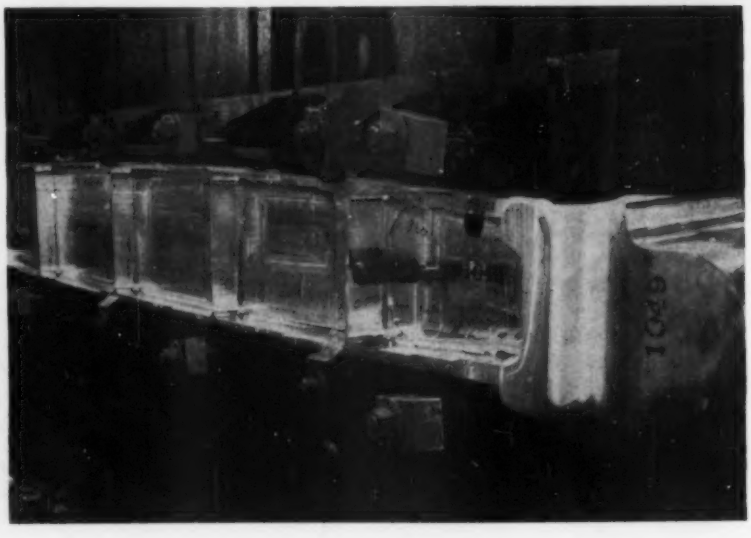
The tool is designed to machine the inboard, outboard, upper and lower surfaces of both the left- and right-hand beams. This eliminates need for a left- and right-hand tool, since now only the templet needs to be changed.

The self-contained clamping system was designed into the machine and, according to the company, the complete unit can be easily removed for milling of other parts. The, clamps are operated by a 2-way air cylinder using standard shop line pressure of 90 to 100 psi.

Each clamp operates in a spiral slot in its clamp post, allowing 90° movement about the centerline of the post.

A safety mechanism is also included: check valves and a pressure switch. Should line pressure drop below a safe level, a flashing red light calls the operator's attention to the change.

Each wing beam . . .
on the Keller machine has its own set of clamps and actuating levers (right). For identification by operator, each handle has a different color keying it to the clamp it controls. Closeup of wing-beam forging (below) shows some clamps rotated 90° to permit milling along edges.



COMING EVENTS

JANUARY

26-29 . . . American Society of Heating & Air-Conditioning Engineers, 14th International Heating and Air Conditioning Exposition, Convention Hall, Philadelphia.

27-30 . . . Society of Plastics Engineers, 15th Annual Technical Conference, Hotel Commodore, New York.

28-29 . . . Armour Research Foundation and American Welding Society, 5th Annual Midwest Welding Conference, Illinois Institute of Technology Campus, Chicago.

28-29 . . . First International Symposium on Solid Nuclear Fuel Elements, McMillan Theatre, Columbia University, NYC, NY.

FEBRUARY

3-5 . . . Society of the Plastics Industry, 14th Annual Technical and Management Conference, Edgewater Beach Hotel, Chicago.

6-7 . . . University of California, 11th Annual Industrial Engineering Institute, Berkeley and Los Angeles Campuses.

23-26 . . . American Society of Mechanical Engineers, Symposium on Thermophysical Properties, Purdue Univ, Lafayette, Ind.

25-26 . . . US Atomic Energy Commissioner and Kansas State College, Midwest Industrial Radioisotopes Conference, Kansas State College, Manhattan, Kansas.

MARCH

3-5 . . . Institute of Radio Engineers, American Institute of Electrical Engineers, Association for Computing Machinery, 1959 Western Joint Computer Conference, Fairmont Hotel, San Francisco.

8-11 . . . American Society of Mechanical Engineers, Gas Turbine Div, Engineering Conference and Exhibit, Netherlands-Hilton, Cincinnati, Ohio.

9-12 . . . American Society of Mechanical Engineers, Aviation Conference, Statler-Hilton, Los Angeles.

16-18 . . . Society of Automotive Engineers, National Passenger Car, Body and Materials Meeting, The Sheraton-Cadillac, Detroit, Mich.

31-April 2 . . . 21st Annual American Power Conference, Hotel Sherman, Chicago.

Earthbound Pilots Fly Jets with Closed Circuit Tv

CARLSTADT, NJ—Curtiss-Wright Electronics Div has unveiled its electronic flight Visulator—a piece of equipment that ties into a flight simulator to train jet pilots. The Visulator makes it possible for a pilot trainee to practice take-offs or landings during the period when he is close to the ground and has to rely on vision rather than instruments.

Variations of the equipment will help train flight personnel for other aircraft and missiles.

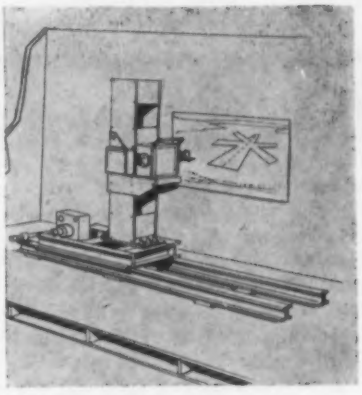
The system includes a closed-circuit TV camera mounted on a dolly which moves across a 3-D scale model of a landing strip in response to the way the pilot handles controls in the flight simulator. The TV projector then flashes to a 25-by 15-ft screen the view of the landing strip the pilot would have if he were actually flying. Instructors who train pilots can create plane failures or other emergencies.

The pilot's handling of his controls affects two independent motion systems in the Visulator: vertical, horizontal or depth movement of the TV camera on the dolly simulate plane altitude, drift and distance from the field; rotation of an optical system at the tip of the TV lens simulates roll, pitch or azimuth swings of the craft.

Main problem in designing the Visulator was getting an optical system that could move to within 0.05 in. of the model landing strip and retain high resolution and perspective over a 90° visual angle. An optical system with this capability makes the Visulator economically practical, a C-W source points out, because an 8-10,000-ft runway can be reduced to a 17-ft model and the entire installation fit into a 25-ft-long, 15-ft-wide studio. With standard pickup and projection lenses, C-W says, the model would measure 75 to 80 ft long and probably require a special building.

The optical system was designed by Perkin-Elmer and consists of 13 lens elements, 5 prisms, and one plane parallel glass plate. To get a 90° view of the landing strip and surrounding air field (90° is the span over which most human eyes pick up visual information, according to consulting psychologists on the project), engineers had to design special lens movements for the optical system. When the entire instrument rotates around one axis, the lenses will picture plane azimuth and roll. Pitch is viewed by combining partial rotation of the lens around the azimuth axis at 45° angle of rotation.

Focus of the lenses is maintained



Flying high on the ground . . . test equipment developed by Curtiss-Wright lets pilots practice visual take-offs and landings in simulated jets. The TV camera above scans a model airfield, giving the pilot a changing image of the field as he would see it in actual flight. Model airfields can be scaled to actual runways the pilots will use, and include city lights buildings and other distractions that affect the way a pilot handles plane controls.

Tip of TV lens . . . that views 3-D model of airfield is shown with standard "wind" match. The specially designed lens is a vital component in Curitss-Wright's electronic Visulator.

by servo-controlled movement of the optical elements. The system that focuses the optical elements is independent of system rotating them.

Urey Hits Excess of Scientific Reports

LOS ANGELES—A Nobel-prize-winning scientist has suggested that most of the scientific reports of US scientists be consigned to an incinerator. Dr. Harold C. Urey (PE, Dec 31, 57, p 37) noted chemist and Univ of Calif professor, drew his oral bow during an American Physical Society banquet in Santa Monica.

Dr. Urey cited a hypothetical case to drive home his point, one which included a number of arrows aimed at piercing present literary burdens imposed on scientists. He was, however, speaking informally, and his remarks were motivated by affection rather than pique for his colleagues. The case concerning a hypothetical physicist employed by a major laboratory.

"He and his associates do some interesting work. Of course, in the present crowded state of physics, of certain kinds at least, three other groups are doing the same thing in almost identically the same way.

"Hence a preprint results. It is long and detailed. It is distributed to many people and laboratories . . . considerably later the material is rewritten, condensed, some references added and it goes to a scientific journal . . ."

"The preprint publication trails off into reports for the National Science Foundation, the Atomic Energy Commission, and now the National Aeronautics and Space Administration.

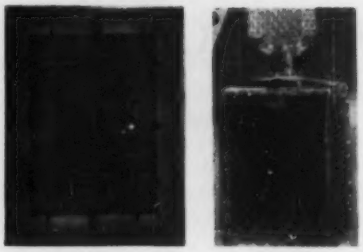
"The literary output (scientific reports) of scientists is getting well nigh out of hand," said Dr. Urey, and suggested a conveyor apparatus to carry scientists' mail "to a truck waiting outside or to an incinerator."

Much of the paper outpouring, Dr. Urey continued, is "due to the absolute necessity of convincing some dispenser of funds, usually in Washington, that he has produced an enormous amount of brilliant work."

CORRECTION

In "New Way to Display High Temperature Data" in Jan 5 page 60, reference to the previous article should have been Mar 31 '58, p 127.

READER TO EDITOR



Our incoming mail recently returned to us a copy of our Dec 8 honeycomb cover with a mysterious piece of paper folded over the red-hot honeycomb. It looked very similar to our cover picture but when unfolded showed a large bottle from a Four Roses whisky ad.

The Ideal Product

To the Editor:

Your articles on the engineering developments abroad led us to work up a pattern of our own. We note that each of the world's industrial nations has a distinct *forte*. The Ideal Product would incorporate the best production characteristics of each nation: It would be manufactured by American mass production and automation; be based on a Belgian invention made possible when a Russian mathematician developed a Swedish scientific theory.

The Ideal Product, composed of Canadian raw materials, would be designed by a French product engineer, and styled by an Italian. Though mass-produced by USA practice, it would meet the standards of British workmanship, German thoroughness, and Japanese attention to detail.

The Ideal Product would be so good (and expensive) that no one could afford to buy it.

—GEORGE H AMBER
Amber & Amber
Detroit

Pressure Transducer Housing

To the Editor:

The molded jacket shown in your Urethane Foam story of Nov 10 (p. 87) does not house a missile-pump motor but a high-accuracy pressure transducer used in our portable Secondary Standard. The temperature of this transducer is controlled with a heater and thermostat which, in conjunction with the molded jacket, maintain the temperature of the transducer within a few degrees over a temperature range from 40 to 110F. With this jacket we can guarantee the accuracy on the primary standard to 0.05% of full scale.

—D C PARKER
Wiancko *Engineering Co*
Pasadena, Calif

Quiet Engine

To the Editor:

With reference to your article, Nov 3, '58, p 18, concerning "Multifuel Engines," I suggest you and the US Army study the M combustion method from the MAN factory, Germany. This method is described by its inventor in the *VDI Zeitschrift*, Vol. 98, pages 595/99 and a discussion about it is in the same magazine, Vol. 100, Nr 10, page 409. I have seen working trucks equipped with the M motor, which is remarkably elastic and noiseless. The Berliet motor described with picture in the same article is only the application of the "M method" (M Verfahren) which means CENTRAL CHAMBER COMBUSTION METHOD.

—H G PETERS
San Francisco, Argentina

Canadian Machine-tool Control

To the Editor:

I was interested to see the announcement for the system of automatic control of machine tools on page 18 of your Dec 1 issue. You may be interested to know this is essentially the same system we devised in 1945 and demonstrated in 1947 in Toronto. The essential features of the system are covered under our US Patent No 2,475,245. —E W LEAVER
Electronic Associates Ltd
Willowdale, Ont

Germans Read Books

To the Editor:

In the Oct 13 issue, in which a Design Roundup contribution of mine appeared, I saw a very interesting "Tangents . . ." entitled "Reading Should Be a Disease" (p 137).

As a proud owner of a library of more than 5000 volumes I was very much interested in what you said and, of course, I agree with you heartily. As a curious coincidence, a couple of days ago I stumbled upon a page from the Hamburg, Germany daily, "*Die Welt*," where an article deals with the same topic. Your information seems to be correct: the 34% German readership of books is confirmed.

—FEDERICO STRASSER
Santiago de Chile

Solution for Baggy Pants

To the Editor:

In the "Why Don't They R & D" column on the last page of your November issue, Mr. R. Myram dislikes baggy pants. A pamphlet issued by the Commonwealth Scientific and Industrial Research Organization describes a treatment for wool fabrics which does what he wants.

—H KING-IRVING
Radio Corporation PTY Ltd
S. Melbourne, Australia

• The report describes a spray of ammonium thioglycollate, a chemical used in permanent waving, followed by 15 seconds of pressing and steaming to make a water-indifferent crease. Patents have been applied for in Australia and Great Britain and the process will be licensed under the trade name SI-RO-SET.—Ed.

LESSON III . . .

FIVE STEPS TO FASTER READING

By THE READING LABORATORY INC

Keeping up with new developments is a time-consuming task. Knowing how to determine the relative importance of a magazine article, report, or business letter is an essential skill in efficient reading. This article will furnish you with a systematic approach to the problem by pre-reading.

But why go through an article twice? Pre-reading first saves time. Not every article is of equal importance to you; pre-reading can help to determine the value of each article in PRODUCT ENGINEERING—to you personally. You can tell whether you want to spend time on a thorough reading, or whether pre-reading will give a sufficient over-all-view.

Even if a thorough reading is found necessary, pre-reading will still save you time and improve your comprehension. Pre-reading will give you a general idea, before you read, of the content of the article and the author's development of ideas. You will thus be able to concentrate on what the author is saying without wondering why he is making a certain point, or what he is leading up to. Most important, you can adjust your reading speed to the complexity of the article.

The pre-reading method:

1. Look first at the title, author, and date.
2. Next, read rapidly the first two or three paragraphs. These almost always introduce the subject in a general way.
3. When the author finishes his introduction and enters the main body of his discussion, begin reading only the first sentence of each paragraph, which almost always expresses the main idea of the paragraph.
4. Glance at pictures, tables, and graphs, which may tell more than two pages of print. Note all sub-heads and bold-faced type, which indicate important steps in the discussion.
5. As you reach the end of the article, the first sentences of the paragraphs will tell when the author is beginning to sum up his discussion. Read these summarizing paragraphs thoroughly but rapidly.

Now that you are familiar with the pre-reading method, turn to the article on page 64. Give yourself two minutes to pre-read it. Remember that pre-reading does not mean two readings. It means getting a rapid, bird's-eye view before you read thoroughly.

In pre-reading technical books:

1. Note the title, author, and date of publication.
2. Read the table of contents and any introductory material. A look through the index is sometimes helpful in seeing what subjects are treated heavily.
3. Pre-read, and then read rapidly, the concluding and summarizing chapters.
4. When reading the book thoroughly, pre-read each chapter as you come to it.

In reading business letters a three-step technique will visually tell you if a thorough reading is necessary. The letterhead will tell you where it is from; the signature will tell you whom it is from; and the first sentence will tell whether the writer is getting right down to business. If he isn't, drop two-thirds of the way through the letter for the central point.

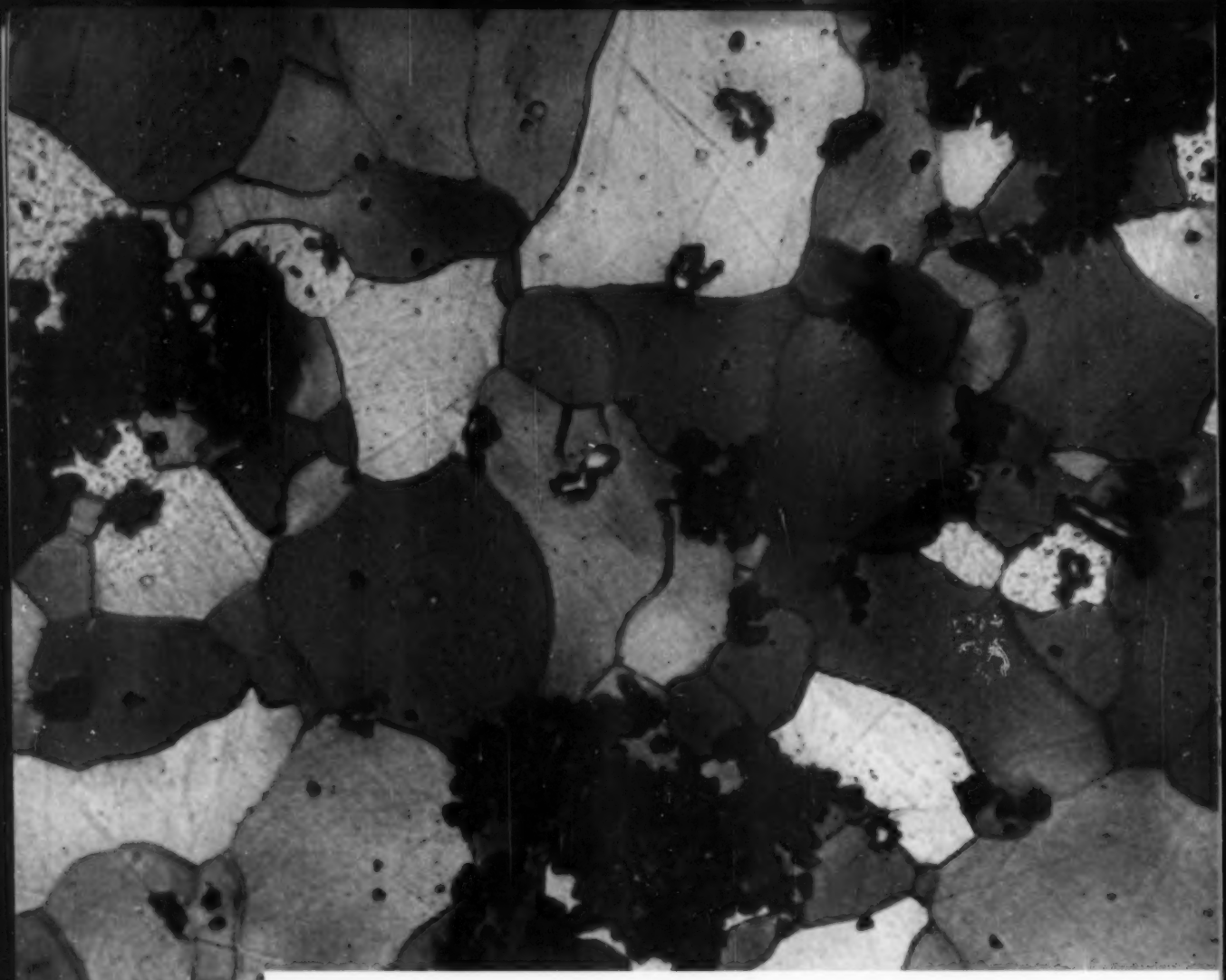
Newspaper editorials, book and theater reviews, may be pre-read as you pre-read articles. News stories, however, contain all of the main points in the first few paragraphs. Pre-read a news story by reading the first paragraph thoroughly, and skimming the second and third paragraphs rapidly.

For faster reading of PRODUCT ENGINEERING, spend 10 minutes in pre-reading the entire magazine by first inspecting the Table of Contents. Then check the department that interests you most. If it is "Design Abstracts" turn to page 122 and pre-read for new ideas. Do this with whatever department is most interesting to you. Then, when you do have time to sit down (even if it's only half an hour), read the "blurbs" for each article on the contents page, then go on to those which interest you most. Pre-read all of them, and spend the rest of your half-hour reading the article which is of most help and interest to you. In forty minutes, then, you have kept up with new developments in your field, you've had a bird's-eye view of the entire contents of PRODUCT ENGINEERING, you've gleaned the major points of two or three articles, and you have read one article thoroughly.

Pre-reading helps you use the techniques of skipping and skimming. If you find that only certain parts of the material are relevant to your purpose, thorough-read only those sections, and skip the rest. If it appears that a particular fact you're looking for is contained in the article, skim to find this fact. Skimming means letting your eye pause—or fixate—only twice on each line, looking for specific facts. This may seem difficult at first, but after practice, you will be able to find the ideas and significant details rapidly.

The next article will discuss methods of improving your concentration. Continue to practice pre-reading until you use this technique automatically on all types of non-fiction material.

A more complete discussion of all aspects of reading improvement, plus practice exercises, is available in the book *Cut Your Reading Time in Half*, written by The Reading Laboratory and available for $1.25 from its publisher, Developmental Research Institute Inc, 500 Fifth Ave, New York 36.



Color micrograph of heat tinted section of ferritic Malleable iron showing random dispersion of temper carbon nodules in ferrite. 625X magnification.

Usability is Malleable

In the growing world of metals, certain requirements remain basic: strength . . . versatility . . . economy. Malleable iron castings uniquely answer all three. Malleable castings provide more strength per dollar than any other metal . . . are the most machinable of all ferrous metals of similar hardness.

From the great range of Malleable irons now produced in modern Malleable foundries, you can select exactly the right metal to fill your most demanding needs for endurance, resistance to impact and wear, ductility and constant uniformity. No other metal offers you so much at so low a cost.

For information or service, call on one of the progressive firms that identify themselves with this symbol—

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If you wish, you may inquire direct to the Malleable Castings Council, 1800 Union Commerce Building, Cleveland 14, Ohio, for information.

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NEW YORK
Acme Steel & Mall. Iron Works, Buffalo 7
Frazer & Jones Company Division Eastern Malleable Iron Co., Solvay
Oriskany Malleable Iron Co., Inc., Oriskany
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Lancaster Malleable Castings Co., Lancaster
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Belle City Malleable Iron Co., Racine
Chain Belt Company, Milwaukee 1
Federal Malleable Company, West Allis 14
Kirsh Foundry Inc., Beaver Dam
Lakeside Malleable Castings Co., Racine
Milwaukee Malleable & Grey Iron Works, Milwaukee 46

How to Select the Best Metal to Perform a Given Set of Functions

Any equipment part can be described, at least approximately, in terms of the functions it must perform. That is, it must provide a certain strength plus resistance to wear, fatigue, impact or corrosion. The finished part must provide the best combination of all necessary factors at the lowest possible cost — a cost that must include machining, finishing and assembly where applicable.

Unique Production Method Combines Desirable Characteristics

The amount and form of carbon in ferrous metals is of prime importance. The carbon content of Malleable iron (2.00 to 2.60%) provides good fluidity at the pouring stage. Yet neither flake graphite nor combined carbon is present in finished standard Malleable iron.

As the photomicrograph of standard Malleable iron shows, the carbon has been transformed into temper carbon nodules in a matrix of ferrite during the heat-treatment given *all* Malleable iron castings. The result is a metal with a unique combination of high strength, toughness and machinability.

Pearlitic Malleable irons differ from standard, or ferritic, Malleable only in that a controlled amount of the carbon is combined with the iron to form a pearlitic matrix around the temper carbon nodules. This increases strength, hardness, wear resistance and modulus of elasticity, while retaining good ductility and machinability.

TENSILE PROPERTIES — A.S.T.M. MINIMUM SPECIFICATIONS

Standard and Pearlitic Malleable Irons				
Designation	Tensile Strength p. s. i.	Yield Strength p. s. i.	Elongation % in 2 in.	Ratio of Tensile to Yield %
Standard				
35018	53,000	35,000	18	66
32510	50,000	32,500	10	65
Pearlitic				
45010	65,000	45,000	10	69
45007	68,000	45,000	7	66
48004	70,000	48,000	4	69
50007	75,000	50,000	7	67
53004	80,000	53,000	4	66
60003	80,000	60,000	3	75
80002	100,000	80,000	2	80

Strengths up to 135,000 p.s.i. tensile and 110,000 p.s.i. yield are produced commercially under individual producers' specifications.

TYPICAL BRINNELL HARDNESS NO. RANGES

Pearlitic Malleable Irons							
Designation	45010	45007	48004	50007	53004	60003	80002
B. H. N.	163-207	163-217	163-228	179-228	197-241	197-255	241-269

New Savings Result

From the wide range of properties obtainable, a Malleable iron may be selected that will most completely meet ideal design and functional requirements. Because of the great latitude of producible sizes, from a fraction of an ounce to hundreds of pounds, Malleable can be used for a wealth of applications.

Malleable iron's economy is derived in two ways. First, the casting process is generally accepted as the most economical method of producing a finished part. Secondly, being the most machinable of all ferrous metals of similar hardness, cast or otherwise, Malleable iron castings provide exceptional economies in time, tool and power consumption.

Today's Malleable iron castings offer tremendous strength, uniformity, versatility and economy. The producers of Malleable castings are anxious to assist you in getting maximum "usability." Why not let their modern design, testing and production facilities work for you?

Send for Special Data Unit

Your copy of Data Unit No. 101 containing additional information on the benefits you can derive from Malleable iron castings is available from any member of the Malleable Castings Council. If you wish, you may direct your request to **Malleable Castings Council, Union Commerce Building, Cleveland 14, Ohio.**

CIRCLE 109 READER SERVICE CARD

CIRCLE 110-111 READER SERVICE CARD→

THE OTHER DESIGN

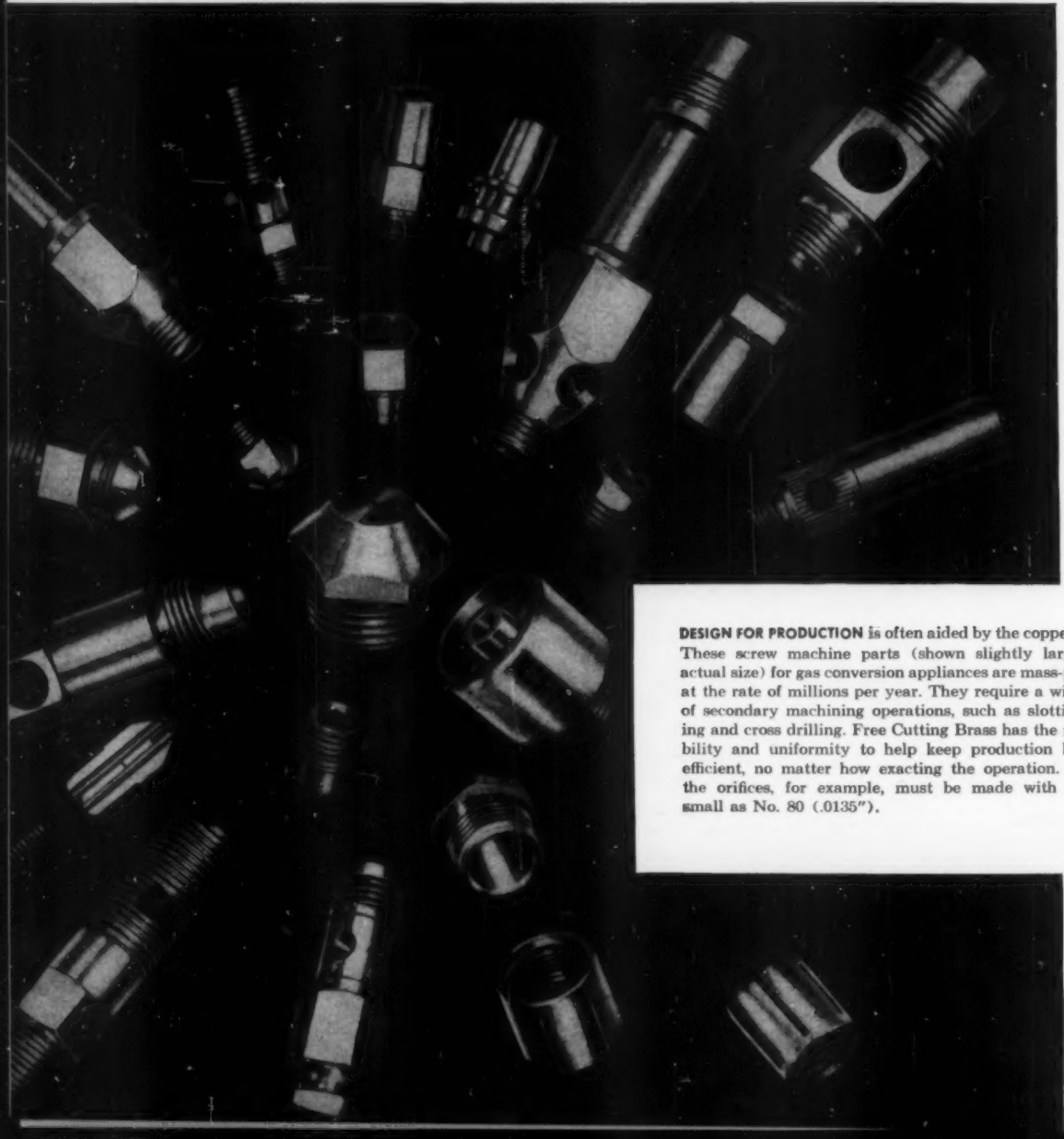
How the copper metals can improve production as well as the product

How freely can you design for performance? How inhibited are you by the production requirements of your equipment and your materials?

When the materials of design are the copper metals, there are many ways, old and new, of converting the pilot model into mass production. In fact, the production versatility of these metals is as important as are their functional advantages. The facility of copper and its alloys for forming, machining, joining and finishing gives the product engineer greater latitude by helping him solve the *other* design problem — the problem of production.

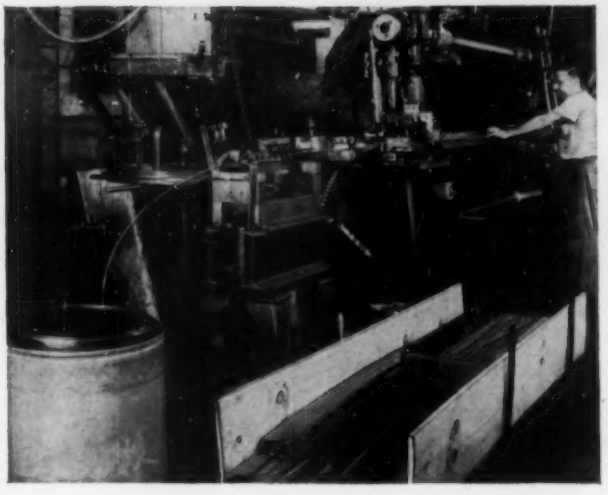
Forming Methods

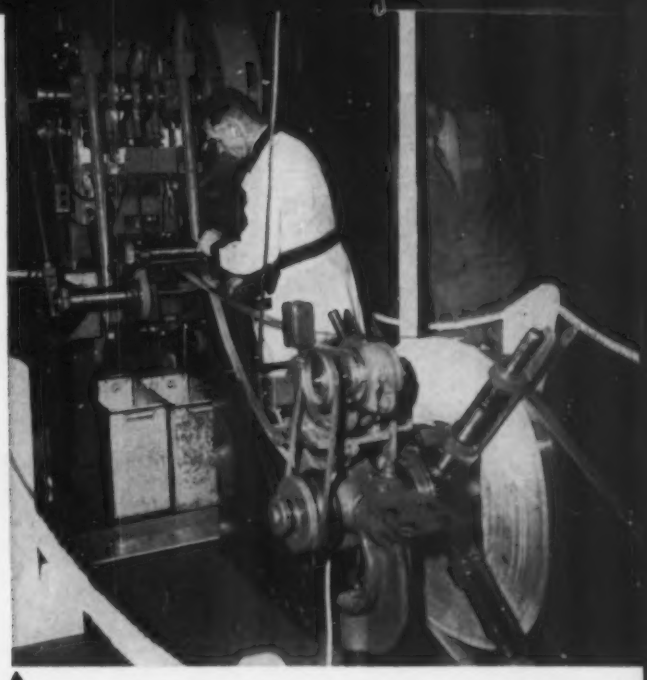
Various of the copper metals have the *ductility* for easy spinning, stamping, pressing, cupping and deep-drawing. They have the *malleability* for intricate and accurate forging, cold heading, coining, embossing, extruding, knurling, swaging, etc. Many are readily *machinable* at high speeds and feeds. They can be *cast* into large or intricate shapes. Copper and its alloys can be easily *soldered* — or, for even stronger



DESIGN FOR PRODUCTION is often aided by the copper metals. These screw machine parts (shown slightly larger than actual size) for gas conversion appliances are mass-produced at the rate of millions per year. They require a wide range of secondary machining operations, such as slotting, milling and cross drilling. Free Cutting Brass has the machinability and uniformity to help keep production high and efficient, no matter how exacting the operation. Some of the orifices, for example, must be made with drills as small as No. 80 (.0135").

PROBLEM





LESS DOWNTIME and less handling result from longer lengths of brass mill products. The barrel-feed coils at left feed a continuous hinge machine for conversion to hinge pins. Long coils of strip above are being drawn into cups in the press.

joints, *brazed* with either silver-base or copper-base alloys. Many of the copper alloys can also be economically joined by modern methods of arc welding and oxyacetylene welding. Some of these methods are entirely automatic.

Manufacturing Economies

A number of factors, besides easy forming, machining and joining, are resulting in considerable savings in the fabrication of the copper metals. These include reductions in manufacturing time due to preforming, reductions in scrap due to the availability of custom shapes from the brass mills, and the high resale value of the limited scrap produced.

Die-pressed forgings and special extrusions of precise cross-sectional form are among these important cost savers. For example, the brass yoke of the float valve shown at right was formed from an extrusion at a savings of 40%, in time and metal, over previous methods. An extruded shape costs more per pound than standard rod or bar, but the reductions in machining, forming and finishing costs may save you far more than the difference in initial price.

CUSTOM EXTRUSIONS SAVE 40% in the fabrication of this brass yoke for a ball-float valve. Custom extrusions like this save both metal and manufacturing time. They machine readily, are accurate in dimensions, and are available in long mill lengths to facilitate automatic operations.

Automation Requirements

The copper metals can make automation more efficient. Machinability is one of the reasons. Many of the alloys can be milled at high speeds and feeds. Tools last longer and downtime is reduced.

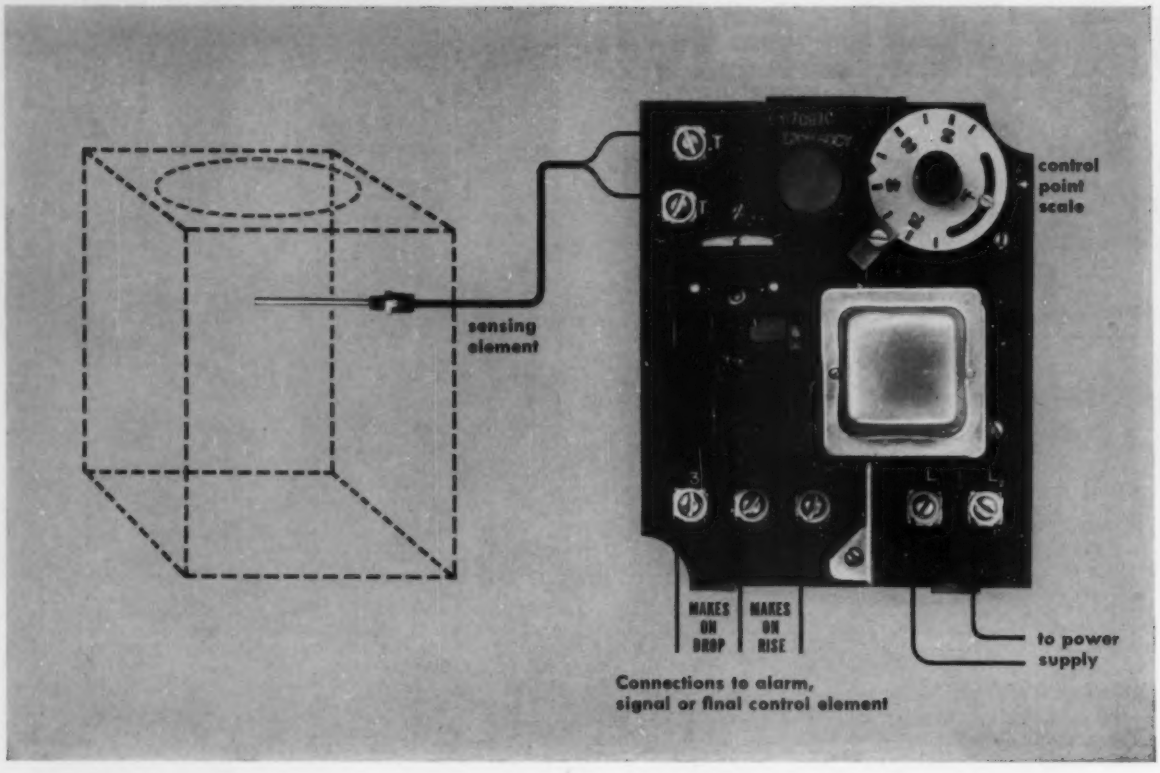
Longer continuous runs are also made possible by the long lengths that the mills can now supply. The barrel-feed coils of wire and the extra-length coils of strip shown above are widely available. Greater-than-mile lengths of .005" gauge Cartridge Brass, 70%, for example, are frequently supplied for use in presses, eyelet machines or roll formers.

These recent developments in the copper industry, and the fabrication properties of the copper metals themselves, let you take full advantage of these metals by helping you to solve "the other design problem" – design for production. A 16-page reprint of "How to Get More for Your Metalworking Dollar – Copper and Brass" is available from the Copper & Brass Research Association, 420 Lexington Avenue, New York 17, New York.

There's a new frontier in...

COPPER · BRASS

BRONZE



Now . . . precise, low-cost temperature control . . . with new VERSA-TRAN®

VERSA-TRAN is an exciting new development in low-cost controls—an entirely different kind of amplifier relay that works with specially designed sensors to control temperature with the accuracy usually found only in more complex instruments.

VERSA-TRAN relays are fully transistorized, vibration resistant, and designed for long, dependable service in even the most demanding applications. They control liquid or air temperatures in overlapping ranges from –60° to 500° F, and surface temperatures from –60° to 200° F.

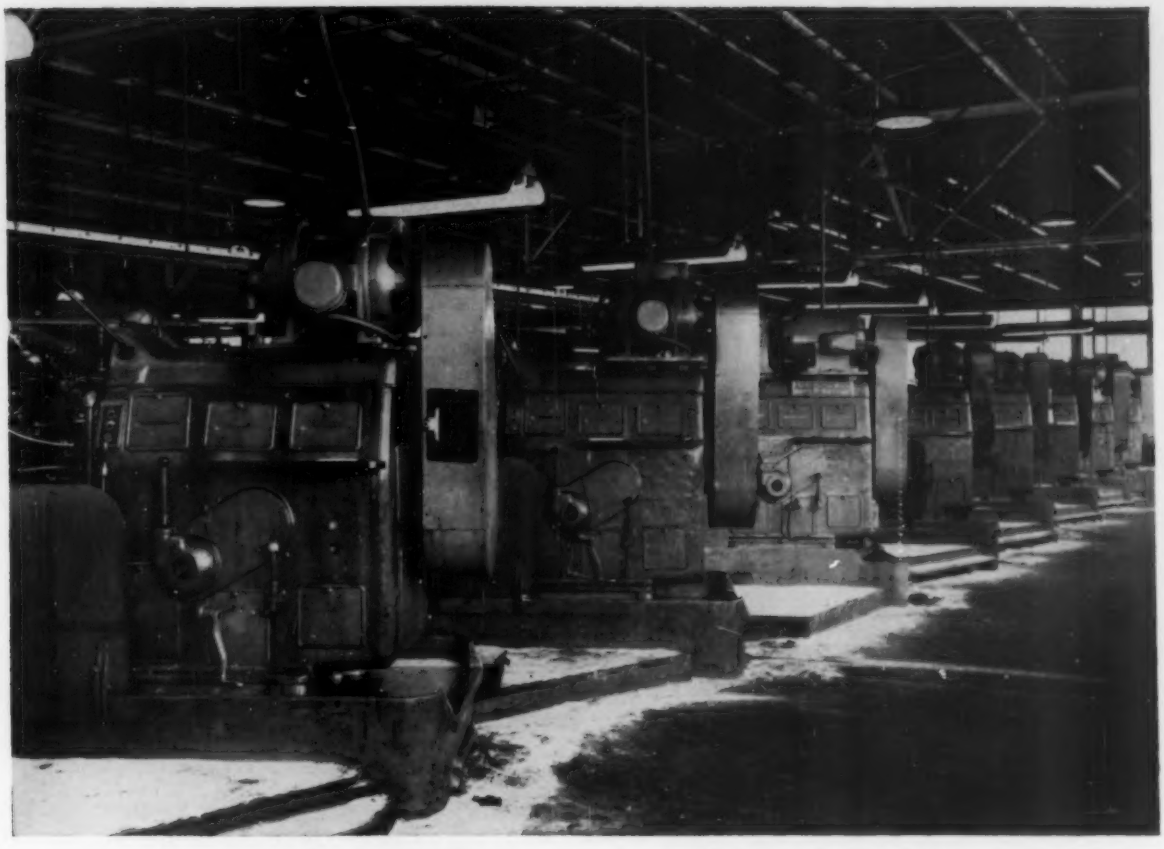
Wiring between the relay and the sensor can be ordinary 18 gauge, 2-conductor cable. The relay is available for flush mounting, surface mounting, or for mounting in most electrical enclosures. It has been accepted for UL listing. VERSA-TRAN gives you flexibility and sensitivity at surprisingly low cost . . . is already solving many difficult control problems.

Your nearby Honeywell field engineer can help you profitably apply new VERSA-TRAN transistorized controls. Call him today . . . he's as near as your phone.

MINNEAPOLIS-HONEYWELL, Wayne and Windrim Avenues, Philadelphia 44, Pa.

Honeywell

H HONEYWELL *First in Control*



Lundberg cuts costs 11% by switching to Timken® hot-rolled seamless steel tubing on National Acme screw machines

TO cut costs, Lundberg Screw Products Company of Lansing, Michigan, investigated the possibility of using hot-rolled tubing on its National Acme screw machines. The question: were hot rolled tolerances adaptable to standard collets.

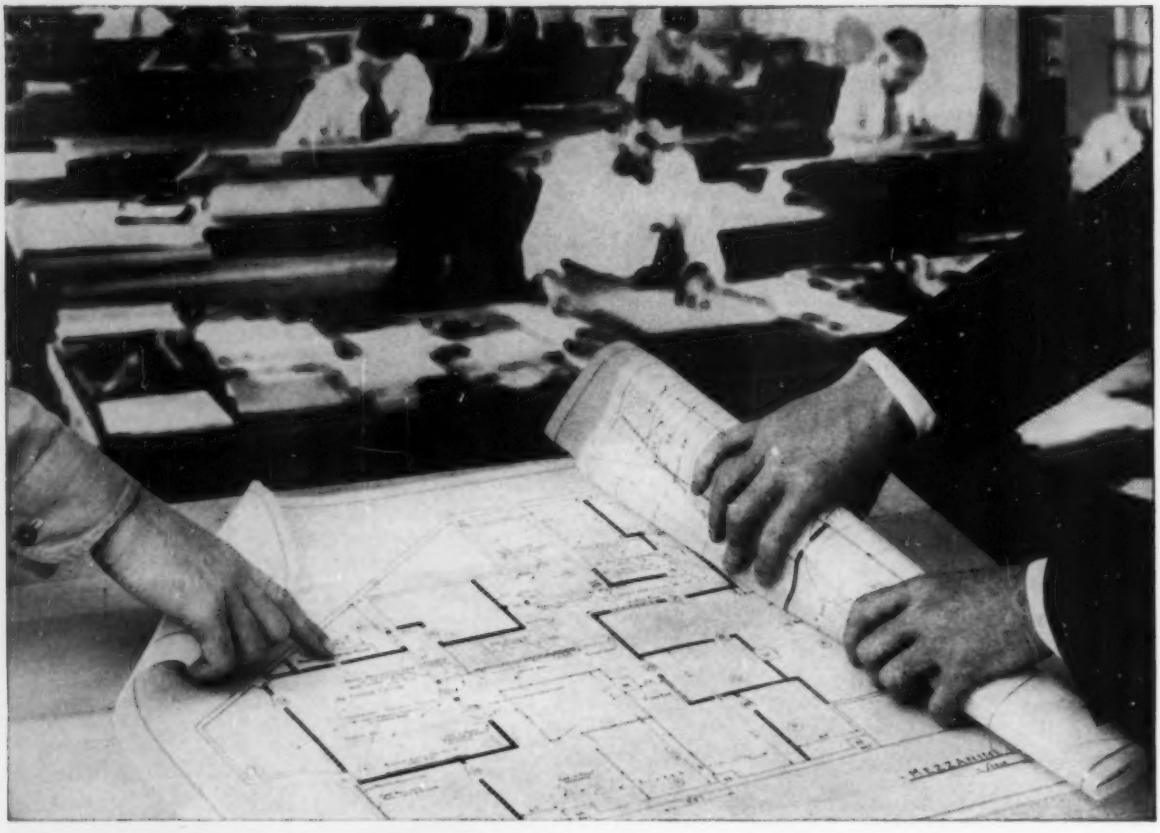
Timken Company sales engineers suggested they try hand chucking. Although hand chucking would mean a slight increase in time due to minor adjustments of collet tension, the material savings would more than offset the higher labor cost. And it did. The manufacturer found these adjustments added 1/10 of an hour per tube to production time. *But* the saving in material cost was *11%*.

Can hot-rolled Timken® seamless steel tubing save money for you? Call us and see. And to further increase your steel savings, ask Timken Company engineers to recommend the most economical tube size for your hollow parts job. We'll guarantee this size to clean up to your dimensions. The Timken Roller Bearing Company, Steel and Tube Division, Canton 6, Ohio. Cable: "TIMROSCO". Makers of tapered roller bearings, fine alloy steels and removable rock bits.

Timken alloy steel and seamless tubing is available from warehouse stock in 44 cities in the United States. Call your local Timken Company sales office for the name of your nearest Timken steel distributor.

TIMKEN® *Fine Alloy* STEEL

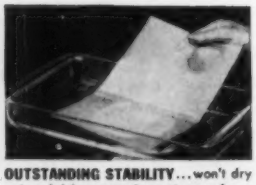
SPECIALISTS IN FINE ALLOY STEELS, GRAPHITIC TOOL STEELS AND SEAMLESS STEEL TUBING



NOW AVAILABLE!

New drafting films made with Du Pont Mylar® resist rough handling . . . safeguard your investment

HIGH TEAR STRENGTH . . . withstands roughest handling, many reproductions.



OUTSTANDING STABILITY . . . won't dry out or shrink . . . remains waterproof.

SUPERIOR TRANSLUCENCY . . . faster, more accurate printing . . . fiber-free.

GREATER FLEXIBILITY . . . rolls up repeatedly without cracking . . . lies flat.

Now you can safeguard your investment in costly original drawings by using the new pencil and ink drafting films made with Du Pont "Mylar"* polyester film. What's more, these crack-resistant drafting films *cost no more* than many grades of cloth!

Look at the remarkable combination of benefits found in these new drafting films! They resist tearing . . . won't embrittle with heat used in reproduction . . . won't yellow with age . . . won't soak up moisture or grease from hands . . . remain waterproof. Next time you order, specify drafting film made with Du Pont "Mylar".

*"Mylar" is a registered trademark for Du Pont's brand of polyester film. Du Pont makes the base material "Mylar"—most leading manufacturers of drafting materials are now offering pencil and ink drafting films made with Du Pont "Mylar".

SEND FOR FREE SAMPLES. See for yourself the many performance advantages you get with new drafting films made with "Mylar" polyester film. Send for your sample sheets today! Write E. I. du Pont de Nemours & Co. (Inc.), Film Dept., Room P-1, Wilmington 98, Delaware.

DU PONT
REG. U. S. PAT. OFF.
BETTER THINGS FOR BETTER LIVING
. . . THROUGH CHEMISTRY

DU PONT MYLAR POLYESTER FILM

This new Square D roller-plunger plug-in limit switch is built for rugged machine tool applications—designed for cam-type operation and not restricted to direct, in-line approach of the actuator. Uses same field-proven precision switch mechanism as roller-arm type for long reliable operation. Moreover, it provides these important features:

Micrometer adjustment for fine adjustment of the roller after the switch has been mounted and wired. ⅛" movement of the roller plunger eliminates expensive cam shimming and adjustment.

Operating direction can be changed 90° for added flexibility. Roller plunger can be set either parallel or perpendicular to the base. No tools required.

Cam-type operation is possible because of the construction of the plunger assembly.

Oil-tight construction for all machine tool applications.

Plug-in construction • Switch plugs in—in seconds.

Easy wiring because all wiring can be done without removing from box.

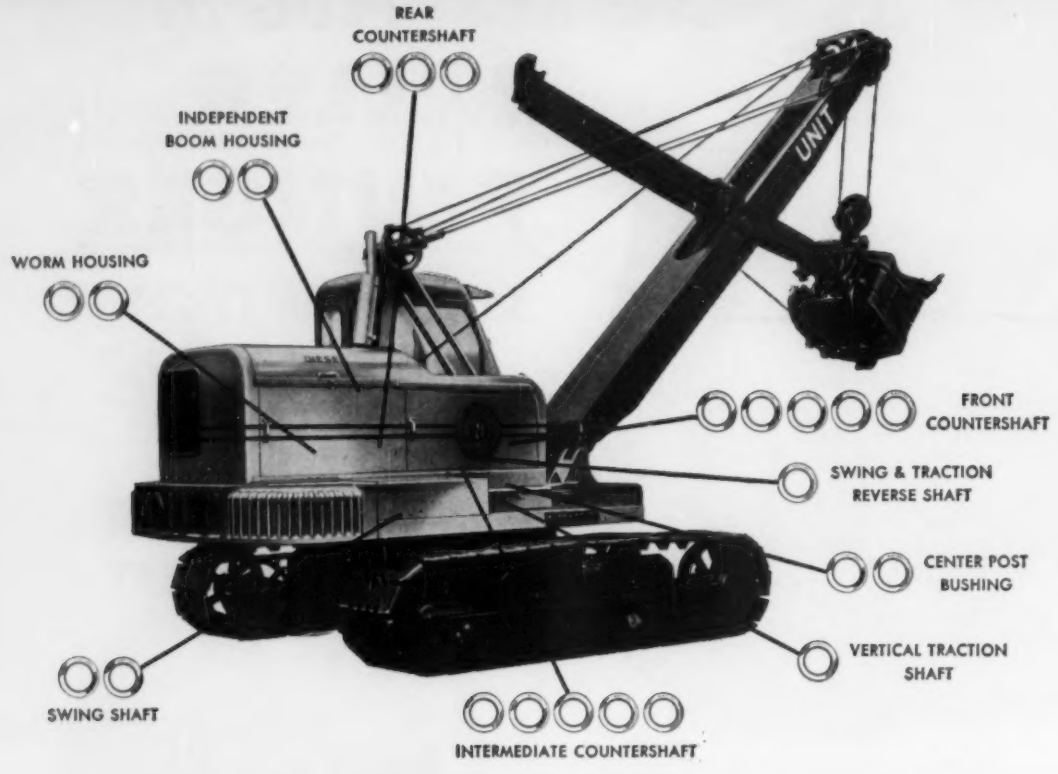
Reversible plug-in unit can be positioned with roller plunger at either top or bottom.

Write for Bulletin 9007 AW. Address Square D Company, 4001 North Richards Street, Milwaukee 12, Wisconsin

EC&M HEAVY INDUSTRY ELECTRICAL EQUIPMENT...NOW A PART OF THE SQUARE D LINE

SQUARE D COMPANY

NATIONAL OIL SEAL LOGBOOK



National Oil Seals used at key points throughout UNIT Crane & Shovel excavators

UNIT Model 1020 pictured above is a ¾ yard diesel excavator designed for maximum convenience and versatility in medium-duty applications. As in other UNIT excavators, National Oil Seals are installed at key points to retain lubricant, exclude dirt and water, and prolong life of bearings and assemblies.

In the UNIT 1020 Excavator, a total of 23 National Seals are employed in 9 basic subassemblies. These include front, rear and intermediate countershaft assemblies, swing traction reverse shaft, the turntable center pin assembly, vertical swing shaft, worm housing and traction shaft assemblies.

Grease seals used in the Model 1020 are of the National 50,000 series design, employing a spring-tensioned leather sealing member mounted inside a precision-made steel outer case. Shaft sizes range from 11/16" in the intermediate countershaft assembly to 8" on the turntable center pin. Similar use of National Seals is made in 11 other excavators offered by UNIT.

National Seals used in the UNIT Model 1020 are all of standard design; National offers over 2,500 different such seals or can design special seals for special requirements. Call your National Applications Engineer. He's listed in the Yellow Pages, under Oil Seals.

NATIONAL SEAL

Division, Federal-Mogul-Bower Bearings, Inc.
General Offices: Redwood City, California
Plants: Van Wert, Ohio, Downey and Redwood City, California

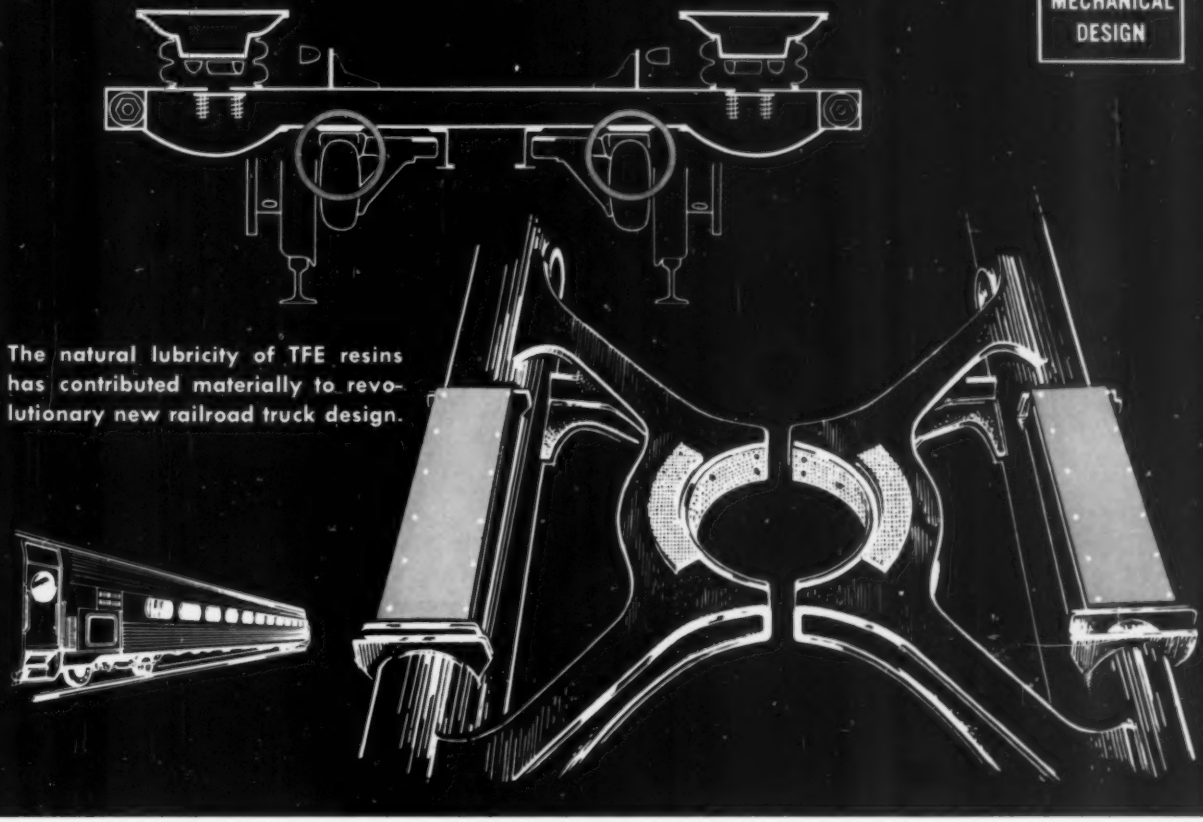
4988

ENGINEERING FACTS ABOUT

TEFLON®

FLUOROCARBON RESINS

NUMBER 1
IN A SERIES
MECHANICAL
DESIGN



The natural lubricity of TFE resins has contributed materially to revolutionary new railroad truck design.

Bearings of TEFLON* TFE-fluorocarbon resins eliminate lubrication... resist heat and chemicals

The two bearings of TFE resins on each truck increase the safety of high-speed trains. When trains travel curves at high speeds, centrifugal force carries the center of gravity "off center," loading the side thrust bearings. The low friction of TFE resins permits the truck to steer out of the curve with a minimum tendency to climb the rail.

These bearings have shown no sign of wear in over 120,000 miles of constant use. The next best material could not hold a lubricant and wore out in less than 10,000 miles.

The coefficient of friction of TFE resins is essentially constant over a wide range of loads. Even the best lubricants on metal surfaces rarely give a value for the coefficient of friction as low as the 0.04 which is readily attained with TFE-fluorocarbon resins. TFE resins do not exhibit slip-stick motion, and squeaking and other noises are eliminated.

This unique property of TFE resins has contributed materially to designs such as the new railroad truck above. There is no extrusion under test loads of 22,000 pounds per bearing. At high loads and low velocities, TFE resins have a lower friction than any other solid material, including graphite and molybdenum disulphide. They have significantly lower static friction than the best lubricated metal bushing (as low as 0.016).

*TEFLON *is Du Pont's trademark for its fluorocarbon resins, including the TFE (tetrafluoroethylene) resins discussed herein.*

OVER

Where to use bearings of TFE resins

Bearings of TEFLON TFE resins are being used where lubricated bearings are incapable of operation, where there is a possibility of lubricant failure and to attain cost savings.

FOR UNEXCELLED PERFORMANCE—Where slip-stick motion is undesirable or where it is the cause of vibration and noise . . . where the lowest possible static friction is desirable (e.g., reciprocating, oscillating and other systems where static friction is prevalent).

TO AVOID LUBRICANT FAILURES—In low temperature applications (-320°F.), where oils are useless . . . with non-lubricating liquids such as gasoline and solvents . . . at elevated temperatures, where common lubricants degrade or vaporize . . . in low humidity, where dry bearings that depend on moisture cannot be used . . . with heavily loaded, slow-speed bearing surfaces that cannot hold lubricants . . . where wear may occur immediately after each start from rest . . . in areas that are inaccessible or are liable to be overlooked.

TO SAVE MONEY—Near substances which must not be contaminated (textiles, food, etc.) . . . where space and weight savings are essential . . . where bearing replacement costs are high, due to: (1) corrosive substances such as strong acids and alkalies . . . (2) high humidity where there is an increased tendency toward corrosion . . . (3) the danger of fretting or galling . . . (4) oil attracting abrasive dust.

DESIGN CONSIDERATIONS

A. SERVICE LIMITS—Bearing performance can be improved by increasing the mechanical properties and thermal conductivity of the TFE resin construction. This can be done with the use of additives or reinforcements such as glass, graphite or metal or by using woven fabric of TEFLON fiber.

These bearings can be tailored to meet your specific requirements of load and velocity. The common PV (pressure times velocity) relationship does not apply over the useful range of TFE resins because the friction varies with the load. Therefore, maximum service limits cannot be expressed as PV alone. The following table provides an indication of the capabilities of the various types of bearings:

UPPER SERVICE LIMITS OF VARIOUS CONSTRUCTIONS*

MATERIAL	LOAD (psi) 2 ft. per minute velocity	VELOCITY (ft./min.) 100 psi load
Unmodified TFE resins	1,000	100
Compounded TFE resins	3,000	200
Metal-reinforced TFE resins	40,000	1,000
Fabric of oriented fibers of TFE resins	60,000	200

*These are values for unlubricated service. With water, acid or oil lubrication substantially higher velocities can be obtained.

B. LUBRICATION—Frequently bearings made of TFE resins are used in lubricated service to reduce starting friction and wear, or in applications where lubrication may be temporarily stopped or overlooked.

In lubricated service the flexibility of TFE resins permits the bearing face to conform to the shaft so that the oil flow required for hydrodynamic lubrication is reduced by several orders of magnitude.

C. STARTING FRICTION—In some bearing applications the starting friction is important. It may either control the efficiency of the equipment or determine the power requirements necessary. The lower coefficient of static friction offered by bearings of TFE resins can often help solve these problems and result in considerable cost savings.

Even at low loads (50 lb.), where starting friction is less of a problem, bearings of TFE resins exhibit static coefficients of 25-70% less than other common bearing materials. It is at high loads, however, that these bearings show their greatest superiority.

This table shows a comparison of the static friction of various flat bearing materials both dry and lubricated.

STATIC COEFFICIENTS OF FRICTION†
TIME AT REST 1 MINUTE

	Ground Cast Iron 20 micro. in. (RMS) 50 lb.	Scraped Cast Iron 20 contact points/sq. in. 50 lb.	Ground Steel 20 micro. in. (RMS) 50 lb.
Glass-Filled TFE resins	DRY 0.148	0.091	0.140
	LUB 0.090	0.094	0.095
TFE resins	DRY 0.079	0.070	0.087
	LUB 0.046	0.098	0.079
Graphite-Filled TFE resins	DRY 0.076	0.130	0.110
	LUB 0.075	0.084	0.087
Bearing Bronze	DRY 0.260	0.250	**
	LUB 0.150	0.211	0.098
Cast Iron	DRY 0.350	0.202	**
	LUB 0.142	0.30	0.123

†Coefficients of friction of flat sliders. By: E. J. Weiter, A. O. Schmidt. Presented at the ASME Semi-Annual meeting—June, 1957.

**Denotes increasing coefficient on successive tests.

SEND FOR MORE INFORMATION

Further details on the design of bearings of TFE-fluorocarbon resins may be obtained from your local supplier . . . look for him under "Plastics—Du Pont" in the Yellow Pages. Supplementary engineering data on the frictional properties of TFE resins and on filled resins will be sent to you on request. Ask your supplier or write to: E. I. du Pont de Nemours & Co. (Inc.), Polychemicals Department, Rm. T36-1-19 Du Pont Building, Wilmington 98, Delaware.

In Canada: Du Pont of Canada Limited, P. O. Box 660, Montreal, Quebec

DU PONT REG. U.S. PAT. OFF.

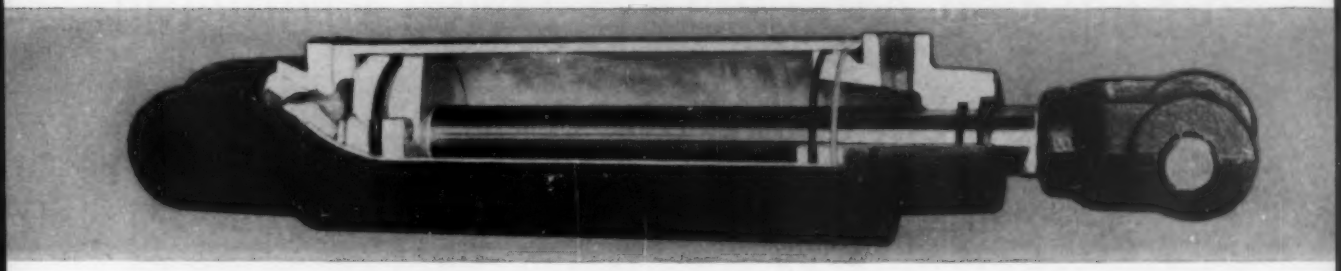
TEFLON®
FLUOROCARBON RESINS

BETTER THINGS FOR BETTER LIVING . . . *THROUGH CHEMISTRY*

There's a HOLE lot of sense in this use of mechanical tubing

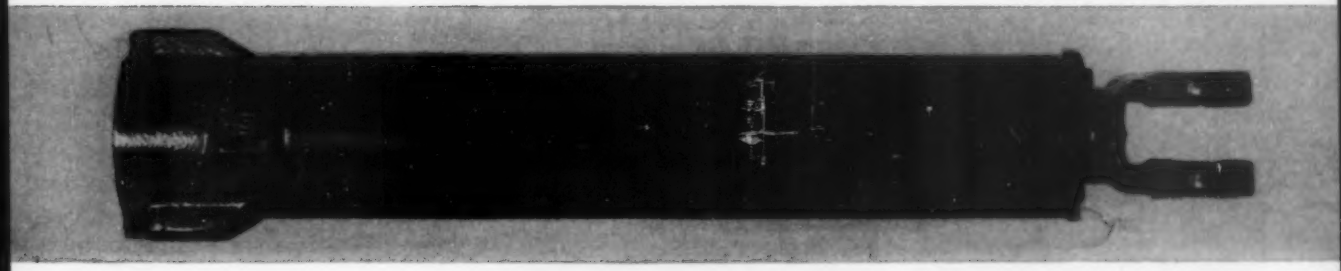
What we're talking about is USS Shelby Seamless Mechanical Tubing. Here's how Industrial Hydraulics Division, Cessna Aircraft Company uses it to boost life, simplify manufacture and lower costs in the hydraulic cylinders they supply to agricultural equipment builders. We quote from their letter to us:

"The cut-away cylinder is a unit we furnish to one of our many customers. This is a 3½" diameter, double-action cylinder used for mounting on pull-behind tools



such as plows, cultivators, and disc harrows. This cylinder uses your Shelby Seamless Mechanical Tubing with the I.D. bored to size and roller burnished to a finish of approximately six to eight RMS. The expected life of this cylinder is in excess of 300,000 cycles, operating at 1,500 psi hydraulic pressure.

"The other cylinder is furnished to another one of our customers, and is a 3¼" I.D. double-action cylinder with a 13" stroke. Used to raise and lower the platform of their self-propelled combine, it is similar to the cut-away cylinder



with respect to finish requirements and material for the barrel. The operating pressure is approximately the same and so is the expected service life of five years, or 300,000 cycles. Generally these cylinders may be serviced for additional use by merely replacing the seals.

"The severe field conditions these cylinders are subjected to are some of the most extreme to which cylinders could be exposed."

In critical mechanical applications like these, and in an almost endless number of fabrications that are essentially tubular in character, Shelby Seamless will ensure improved performance, finer appearance and economical production.

For Shelby Seamless offers more than just a pre-bored hole. It not only combines to an exceptional degree the qualities of strength, uniformity and dimensional accuracy but, in addition, is readily workable and has excellent machining properties. If you want to find out how it can be most effectively applied to your designs, contact your nearby Shelby Distributor.

And remember—USS Shelby Tubing is made by the world's largest and most experienced manufacturer of tubular products.

USS and Shelby are registered trademarks

National Tube Division of USS United States Steel

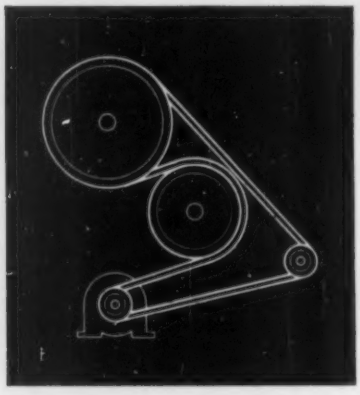
Columbia-Geneva Steel Division, San Francisco, Pacific Coast Distributors
United States Steel Supply Division • United States Steel Export Company, New York

CIRCLE 117 READER SERVICE CARD

A special V-Belt Engineering Service to help you cope with 7 Drive Problems created by space-saving modern design

A checklist of V-belt drive designs which require specialized engineering. With a description of the compensating characteristics which can be built into special Dayton V-Belts. Sources: Case histories from the files of the Dayton Special V-Belt Engineering Service and "The Dayton Handbook of V-Belt Drive Design and Selection."

Here's a typical example of efficient, compact, modern design—an automatic washer with a Dayton V-Belt Drive.

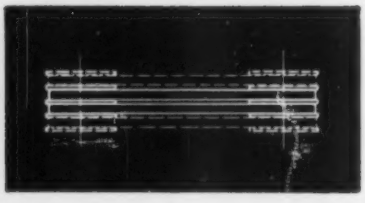


Note that it imposes three design requirements, (1) a torturous back bend (2) sub-diameter pulleys (3) a limited tension take-up area. Yet the design is efficient because Dayton V-Belt engineers developed a belt especially adapted to these three punishing conditions.

You'll find similar examples in machine tools, agricultural machinery and wherever drive space is limited. You've seen them yourself—the designs which dictate sheave misalignment, back-side idlers, underbelting; plus others which use V-Belts as a clutch and which impose excessive shock loads on the belt.

HERE ARE THE MAJOR CONDITIONS WHICH AFFECT V-BELT PERFORMANCE

Underbelting

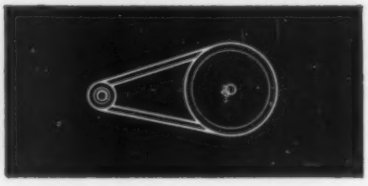


Underbelting is found where space is limited or as a result of very low belt speeds. It will cause belts to slip, run hot and wear out very quickly. A temporary cure, commonly employed, is to over-tension the belt – thus throwing excessive loads on the bearings.

The design requires a high capacity belt with extra-strength cords found in Dayton's Super-Thorobred series or, in difficult cases, belts with both a high coefficient of friction and extra strength like the raw-edge Dayton Cog-Belt.*

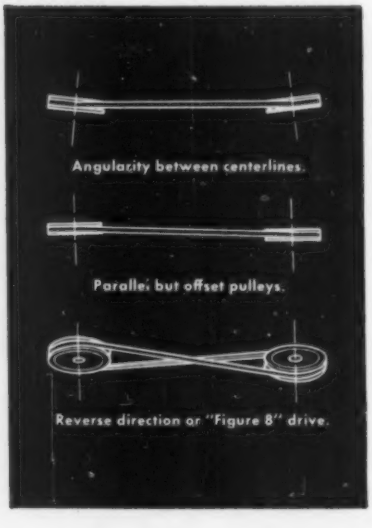
Sub-diameter sheaves

Belts driven by sub-diameter sheaves are inclined to succumb to accelerated flex failure. Tensioning problems are a usual result.



Sub-diameter sheaves require extremely flexible belts for satisfactory service. The required flexibility may be obtained by using thin V-Belts—where drive capacity is not high. When considerable capacity is required, Dayton Cog-Belts will give the most satisfactory performance. Their exclusive design permits exceptional flexibility. Die-cut raw edges provide high coefficient of friction, transmit maximum power from sub-diameter sheave arcs.

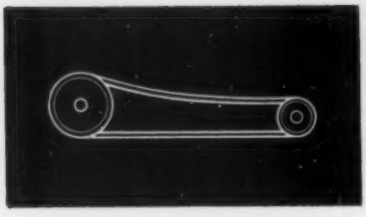
Misalignment



Misalignment causes uneven tension across the face of the belt—producing abnormal belt and pulley wear and uneven bearing loads.

A suitable approach is to use highly extensible cords of the latest synthetic fibers in the strength band of the V-belt. Dayton's Development Engineer can prescribe the material best suited to your needs.

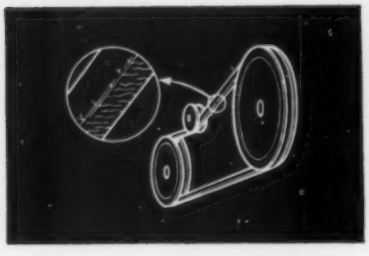
Fixed centers



Proper tension cannot be maintained with fixed centers or where center distance adjustment is inadequate. Without proper tension, belts slip and need frequent replacement.

Dayton V-Belts with low-stretch neutral-axis cords are best suited for applications with little or no provision for center distance adjustment. Still higher performance is gained if the belts have maximum cross-sectional stability which helps keep the belt from seating in the sheave groove.

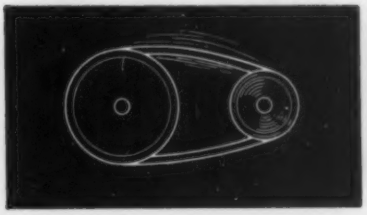
Back-side idlers



Cracks will appear on the under side of the belt, since back-side idlers force the belt to flex in a direction contrary to its construction. Use of spring-loaded back-side idlers may result in belt-snapping.

Where back-side idlers are used to provide tension take-up, they must never be smaller than the smallest pulley in the drive. Dayton V-Belts used in this case employ tension or stretchy type materials in the compression section and have a relocated neutral axis.

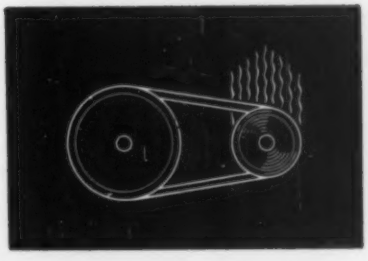
Excessive shock



Excessive shock can cause the belt to snap as well as promote bearing troubles and sheave misalignment.

Belts subject to excessive shock or heavy pulsation require strength band constructions which offer changeable ratios between stress and strain without taking a permanent stretch. Belts with soft cross sections – that will ride up and down in the groove – work well under shock as do wide angle belts. Any of these belts are available from Dayton.

Using as a clutch



V-Belts are ordinarily designed for constant loads and will burn when used as a clutch.

But, belts especially designed for use as a clutch will readily slip when a load is suddenly applied or released. Dayton cover stocks used here have a low coefficient of friction and high resistance to wear.

DAYTON'S SPECIAL V-BELT ENGINEERING SERVICE

Make use of Dayton's Special V-Belt Engineering Service when you encounter any of these designs. Your Dayton V-Belt design engineer is an expert who has devoted himself exclusively to V-Belt Drives. Your design may permit a minor modification which would adapt it to the use of low-cost standard V-Belts. Other standard Dayton V-Belts available for special applications are the Double-Angle V-Belt, the Double Cog-Belt, the Variable Speed Cog-Belt and the Back-Side Idler V-Belt.

With one of the finest research and development laboratories in the industry, Dayton research engineers constantly advance V-Belt knowledge. They develop basic theory, prove the characteristics of the newest compositions and materials available to the rubber industry and test the performance of theoretical constructions. All of this acquired information is at your call when you need a special V-Belt.

Now, while your design is on the drawing board, is the time to call your Dayton V-Belt design engineer. He'll help you select the V-Belt which is tailored to your specific drive. The result – a compact, versatile design which meets all your minimum design requirements and one that will give its users years of trouble-free service.

Industrial Sales Engineers in Atlanta, Chicago, Cleveland, Dallas, Dayton, Minneapolis, Moline, New York, San Francisco and St. Louis.

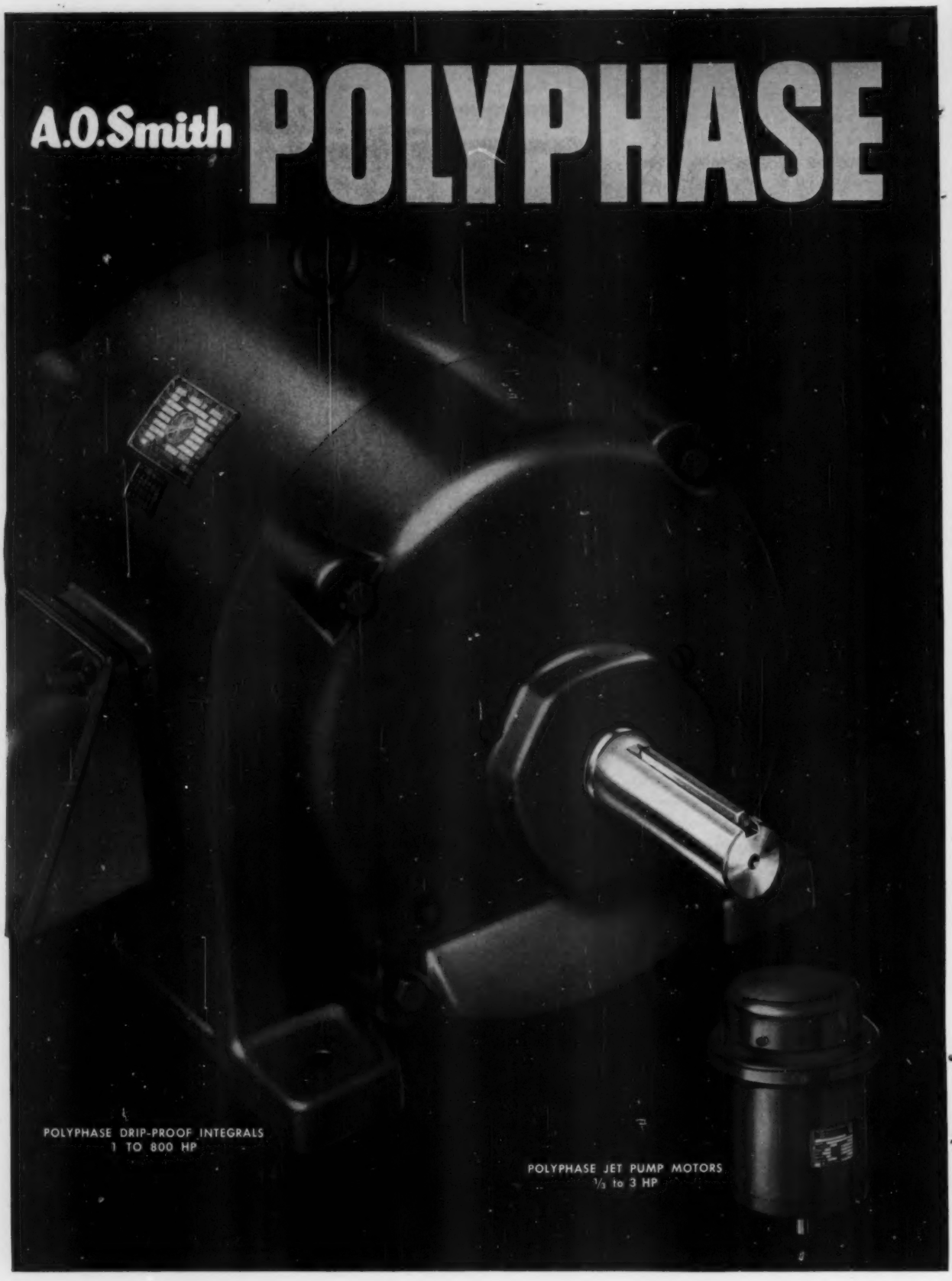
*T. M. © D. R. 1957

Dayton Rubber

THE DAYTON RUBBER CO., INDUSTRIAL O.E.M. DIV., DAYTON 1, OHIO
WORLD'S LARGEST MANUFACTURER OF V-BELTS

If you haven't received your copy of Dayton's authoritative Handbook of V-Belt Drive Design and Selection, write for it now. Just give us your name, title, and the address of your firm.

A.O.Smith POLYPHASE



POLYPHASE DRIP-PROOF INTEGRALS
1 TO 800 HP

POLYPHASE JET PUMP MOTORS
1/3 to 3 HP

MOTORS

1/3 to 800 hp

YOURS from the case of the A. O. Smith motor man

POLYPHASE FRACTIONALS ⅓ to 1 HP
rigid or resilient bases

VERTICAL HOLLOW SHAFT POLYPHASE
INTEGRALS 1 to 700 HP

VERTICAL SOLID SHAFT POLYPHASE
INTEGRALS 1 to 800 HP

TEFC and EXPLOSION-PROOF POLYPHASE
INTEGRALS 1 to 500 HP

CLOSE-COUPLED POLYPHASE PUMP
MOTORS 1 to 150 HP

Here's what amounts to "supermarket" variety — eight basic types of polyphase motors, each available in a wide range of sizes and with practically any electrical or mechanical modification needed.

But in addition to wide choice that helps you get the motor best suited for your application, you get scores of quality features that pay off in uninterrupted service, longer operating life, lower maintenance cost. Every motor is designed to offer ample protection against temporary overloads or voltage drops. You get balanced insulation to afford maximum protection against phase-to-phase or phase-to-ground breakdowns during high amp surges.

All the engineering assistance you want or need is available for designing a motor into your product or applying standard models. What's more, many models are available from stock, in both old and current NEMA frame sizes.

For complete details, contact your A. O. Smith motor man or write direct.

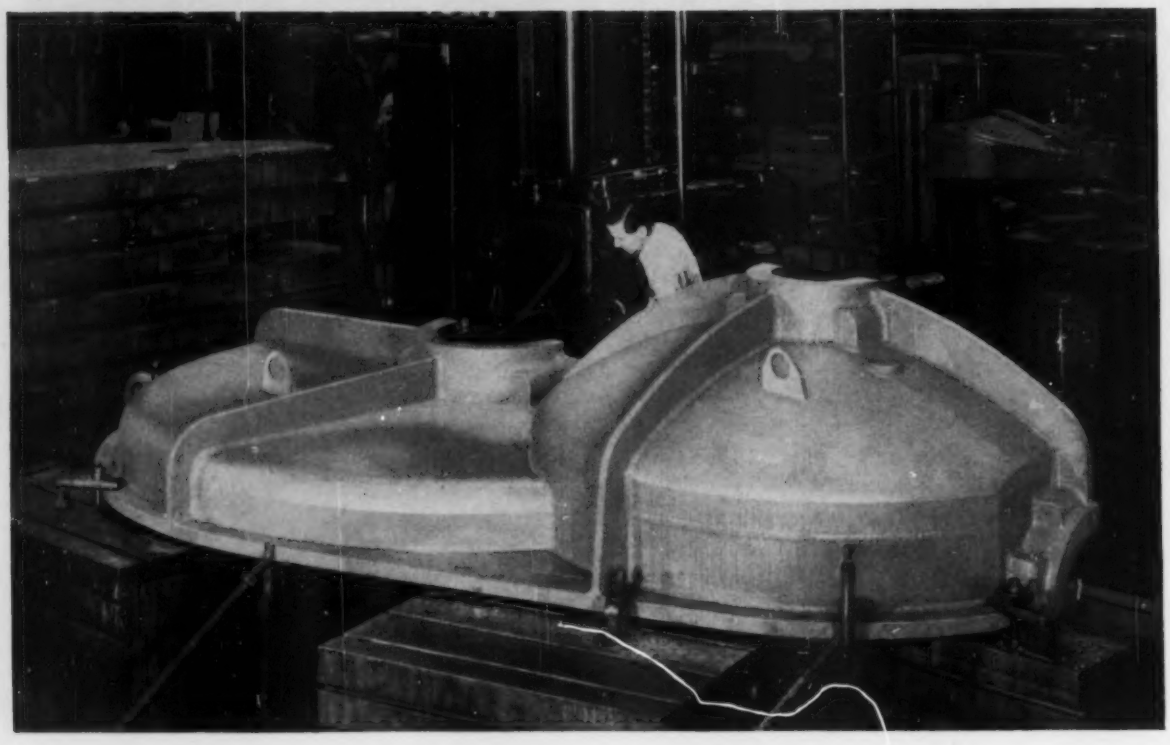
GEARMOTORS 1 to 25 HP are also available with electrical or mechanical modifications to meet your specific requirements.

Through research ...a better way

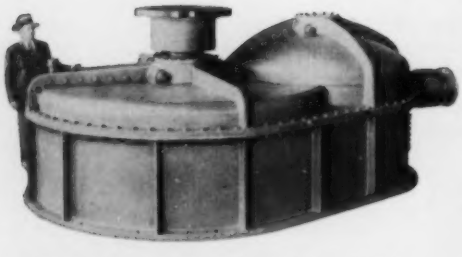
A.O.Smith
CORPORATION

ELECTRIC MOTORS
Tipp City, Ohio
A. O. Smith International S. A., Milwaukee 1, Wisconsin, U. S. A.

STEEL-WELD FABRICATION . . .



PRECISION WELDMENTS Fabricated and Machined to Specification!



FABRICATED, MACHINED and ASSEMBLED IN THE MAHON PLANT

The weldment illustrated above is one of two similar parts of a gear housing for a large speed reducer. The craftsmanship which is plainly evident in this piece is typical of Mahon precision in the production of thousands of Steel-Weld Fabricated parts and assemblies produced year after year for manufacturers of processing machinery, machine tools, and other types of heavy mechanical equipment.

When your design calls for weldments of any kind, you, too, will want to discuss your requirements with Mahon engineers; because, in the Mahon Company you will find a unique source for weldments or welded steel in any form . . . a fully responsible source with a long and enviable performance record, and unusual facilities for design engineering, fabricating, machining and assembling.

See Sweet's Product Design File for information, or have a Mahon sales engineer call at your convenience.

THE R. C. MAHON COMPANY • Detroit 34, Michigan

SALES-ENGINEERING OFFICES in DETROIT, NEW YORK and CHICAGO

Use WELDED STEEL for 100% Predictability and Greater Strength with Reduced Weight!

MAHON

1508 HOSE FOR VERY HIGH SURGE PRESSURES
multiple spiral wrap reinforcing wires of high tensile steel
seamless synthetic inner tube withstands temperatures from —40°F. to 200°F.
tough synthetic rubber cover resists abrasion, mildew, oil soaking

1509 HOSE FOR HIGH OPERATING PRESSURES
double wire braid reinforcement
seamless synthetic inner tube withstands temperatures from —40°F. to 200°F.
tough synthetic rubber cover resists abrasion, mildew, oil soaking

Design High Pressure Fluid Systems Up to 5000 psi.

WITH AEROQUIP FLEXIBLE HOSE LINES

Aeroquip offers two basic hose types to meet most high pressure fluid line requirements:

1508 Hose with wire wrap reinforcement
1509 Hose with wire braid reinforcement

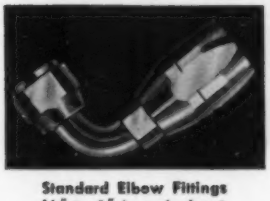
Engineering tests indicate that the braided hose reinforcement is ideal on systems with 'normal' operating pressures up to 5000 psi., while the multiple spiral wrap hose reinforcement affords longer service life on systems subject to abnormal or frequent surge pressures.

In addition, the spiral wrap construction of 1508 hose gives it longer life than braided hose under severe operating conditions such as constant flexing, heavy vibration and shock.

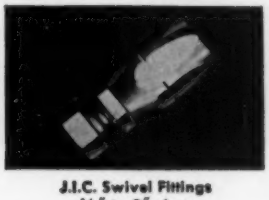
All Aeroquip Hose Fittings are detachable and reusable. They are designed to provide leakproof performance even at burst pressure of the hose.

Call on Aeroquip to furnish any type of special fitting or tubing configuration to solve your piping problem. Our extensive engineering and manufacturing facilities enable us to furnish fast delivery on specials.

Get full product information on Aeroquip High Pressure Hose Lines by returning the coupon below. If you have a specific fluid line problem, outline your requirements and an Aeroquip Sales Engineer will call on you.



Standard Elbow Fittings
¼" to 1" in swivel nut, ½" to 2" in split flange and standard 4-hole flange ends



J.I.C. Swivel Fittings
¼" to 2" sizes

Split Flange Fittings
(O-ring shoulder) ½" to 2"

Male Pipe Fittings
¼" to 2" sizes

Aeroquip

AEROQUIP CORPORATION, JACKSON, MICHIGAN
INDUSTRIAL DIVISION, VAN WERT, OHIO • WESTERN DIVISION, BURBANK, CALIFORNIA
AEROQUIP (CANADA) LTD., TORONTO 18, ONTARIO
AEROQUIP PRODUCTS ARE FULLY PROTECTED BY PATENTS IN CANADA, U.S.A. & ABROAD

Aeroquip Corporation, Jackson, Michigan PE-1

Please send me a copy of Aeroquip Industrial Catalog No. 202 for full information on High Pressure Hose Lines.

Name_____

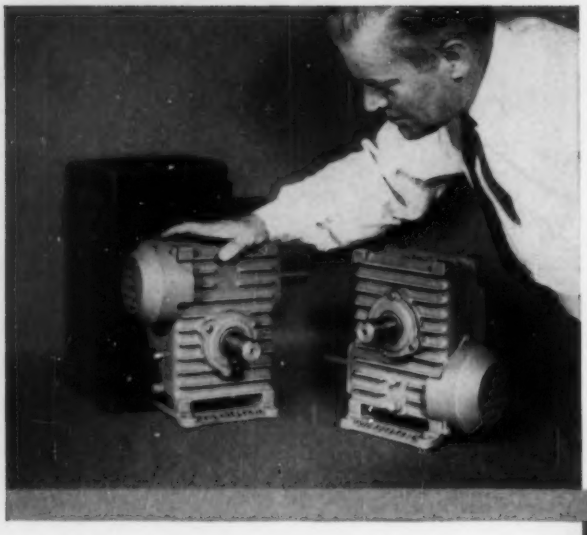
Title_____

Company_____

Address_____

City_____ Zone_____ State_____

new high capacity fan cooled reducers take up 50% less space



LOOK AT THE SPACE YOU SAVE!

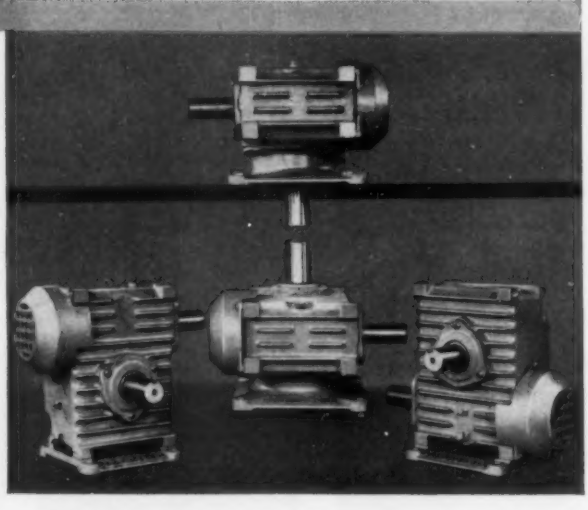
Think what this can mean to your products! You can make important savings in space and weight . . . in the neighborhood of 50% . . . depending upon output torque requirements. Or, you can design for heavier loads . . . up to 80% . . . without adding an ounce of weight to your product. You get more horsepower per dollar!

This new line of Philadelphia Fan cooled Worm Gear Reducers is available in 3, 3½ and 4″ center distances for ratios from 5 1/6:1 to 60:1. Fan cooling, sturdy finned housings, improved tooth forms, precision ground alloy steel worms and special high strength bronze gears all combine to give you a drive that will handle heavier loads in less space.

STANDARD STOCK PARTS SIMPLIFY SELECTION.

These new fan cooled units have a degree of simplicity and flexibility never before available. Standardized housings, fans, gearing and mounting bases permit you to select any drive arrangement you need . . . permit us to give you prompt delivery from stock.

They simplify your design problems too. For Example: horizontal units can be furnished without mounting bases. Housings can be designed as an integral part of your product.



For more information . . . horsepower ratings . . . dimensions . . . construction details . . . write for your copy of Bulletin WG-583.

PHILADELPHIA GEAR CORPORATION

Erie Avenue and G Street • Philadelphia 34, Pennsylvania

philadelphia gear drives

Offices in all Principal Cities • Virginia Gear & Machine Corp., Lynchburg, Va.

INDUSTRIAL GEARS & SPEED REDUCERS • LIMITORQUE VALVE CONTROLS • FLUID MIXERS • FLEXIBLE COUPLINGS

Now...MORE ball bearing types and a bright, new package

Hoover is widely known as a leading producer of open, shielded and sealed types of deep-groove ball bearings, double row bearings and water pump bearings. These Hoover products have earned a long standing reputation for quality.

Now, three new series are added to the Hoover line: 1) pillow block bearings and companion flange bearings; 2) 3L00 extra light bearings for maximum shaft and minimum housing dimensions; 3) "Super Max" bearings for maximum capacity applications.

All these new bearings meet Hoover's high quality standards. All are made with smooth *Hoover Honed* raceways and *Micro-Velvet* balls, accurate within millionths of an inch. All are designed for superior performance and long life.

New, too, is the distinctive blue and yellow package, designed to help you recognize Hoover bearings quickly and to remind you that they are *tops in quality*.

hoover

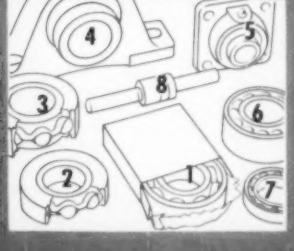
BALL AND BEARING COMPANY

5400 South State Road, Ann Arbor, Michigan

Los Angeles Sales Office and Warehouse: 2020 South Figueroa, Los Angeles 7, California

Chart at Right Identifies Bearings Pictured Above
Use Squares to Check the Information You Want

- ☐ 1 Single Row Deep Groove Bearing.
- ☐ 2 Lubricated-for-life Bearing with Seals of TEFLON*.
- ☐ 3 Cartridge Bearing.
- ☐ 4 Pillow Block Bearing.
- ☐ 5 Flange Bearing.
- ☐ 6 Double Row Bearing.
- ☐ 7 3L00 Extra Light Bearing.
- ☐ 8 Fan and Water Pump Bearing.



Name _____

Title _____

Company _____

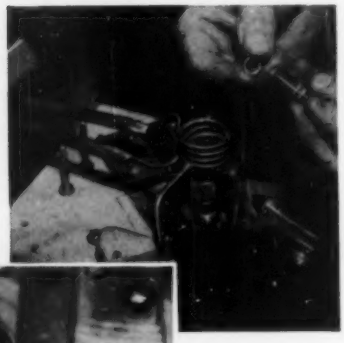
Address _____

City _____ Zone ____ State _____

Hoover Honed and *Micro-Velvet* are Hoover trademarks.
*TEFLON is a DuPont trademark.

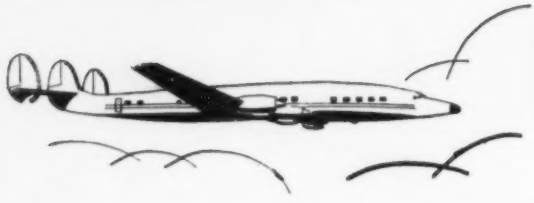
B-1 Flux is particularly effective in removing refractory oxides such as those formed in stainless steels.

Operator fits preformed ring of BRAZE 541 prior to fluxing. This is a hose and tube assembly for an oil line.



Here operator applies gas-air torch, hand-feeding BRAZE 541 to joint.

Oil-bearing unit under induction heating.



Here's How Stainless Steel Fuel Systems Benefit From

HANDY & HARMAN SILVER BRAZING

Tube Processing Corporation, Indianapolis, Indiana, makes aircraft and missile fuel systems and, if anything has to be more failure-proof than a fuel line assembly in an airplane, you name it. The units shown here are made of 410 stainless steel tube and 321 stainless steel fittings; when they're joined, they must be joined permanently. Exhaustive tests, including X-ray, pass on each assembly before final acceptance.

Operator placing oil line (of another type) in induction heating ring.

To meet all requirements: strength, ductility, liquid and airtightness, production speed and economy, Tube Processing uses Handy & Harman's special alloy BRAZE 541 (formerly Alloy 4772) and HANDY B-1 FLUX.

Developed strictly for brazing stainless, BRAZE 541 is one of many Handy & Harman brazing alloys—both standard and special—made to do a specific job and do it better than any other metal-joining method.

Name your product and the metals it's made of, the chances are very good indeed that one of Handy & Harman's silver brazing alloys can join it better than the method you now employ. Better from every aspect: economy, speed, strength, conductivity, labor savings. Put your product in these pictures for the same benefits.

An exclusive additional benefit is Handy & Harman's application Engineering Service. This is a service that exists to show you how these benefits can best be applied to your product. We invite you to take advantage of both Handy & Harman Brazing Alloys and Engineering Service.

GET THE FACTS

Technical Bulletins T-1 and T-2 give the general characteristics of silver brazing alloys plus the compositions, melt and flow points of 32 separate alloys. Write for your copies.

Your NO. 1 Source of Supply and Authority on Brazing Alloys

HANDY & HARMAN

General Offices: 82 Fulton St., New York 38, N. Y.

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"WEIRKOTE'S® SOMETHING SPECIAL! IT CAN END THE NEED FOR ANY FURTHER CORROSION PROTECTION AFTER FABRICATION."

Q. You mean it? Weirkote can save you the cost of any further processing for corrosion protection after fabrication?

A. Absolutely. It's the continuous process that does it. Integrates the zinc to the steel so tightly there's never any peeling or flaking. No matter how severe the fabrication—any torture test you put it through—that bond stays put!

Q. Hmmm. Weirkote sounds great. One thing—is its zinc coating uniform throughout?

A. To the nth degree! Even the hardest-to-reach areas on the most complicated fabrications are completely protected.

Q. Corrosion-protected, you mean?

A. Corrosion-protected all over! So much so that you can work Weirkote to the very limits of the steel itself. So there you have it: stepped-up manufacturing efficiency, sharply curtailed manufacturing costs. All from Weirkote!

Send for free booklet that details the time-and-cost-saving advantages of skin-tight zinc-coated Weirkote. Just write Weirton Steel Company, Dept. D-1, Weirton, West Virginia.

CIRCLE 127 READER SERVICE CARD

WEIRTON STEEL COMPANY

WEIRTON STEEL COMPANY

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a division of

NATIONAL STEEL CORPORATION

The Panelbuilder

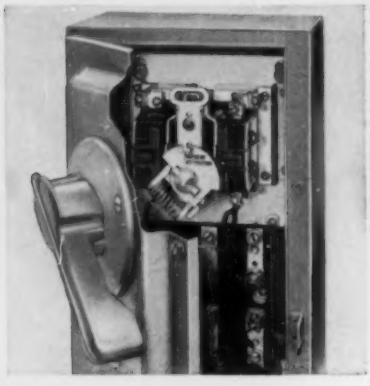
87 YEARS OF SERVICE
CUTLER-HAMMER CONTROL CH

News for and about Panelbuilders

Cutler-Hammer Inc., Milwaukee, Wis. • *Division:* Airborne Instruments Laboratory. • *Subsidiary:* Cutler-Hammer International, C. A.
Associates: Canadian Cutler-Hammer, Ltd.; Cutler-Hammer Mexicana, S. A.; Intercontinental Electronics Corporation.

CUTLER-HAMMER MOTOR DISCONNECT SWITCH SIMPLIFIES PANEL ASSEMBLY

Panelbuilders using the Cutler-Hammer 10904 Motor Disconnect Switch report it provides important savings in time and effort in the assembly of their control panels. The complete unit consists



7/16" radial adjustment of the cover mounted mechanism assures correct alignment with panel mounted disconnect switch.

of a contactor type disconnect switch mechanism, adjustable operating shaft, cover interlock, and external operating mechanism. The switch mechanism uses the same basic structure of the famous Cutler-Hammer Three-Star Contactor, and is easily panel mounted and wired. To mount the external operating handle mechanism, five holes are drilled in the cover following template directions provided with each unit. Exact alignment of these mounting holes with respect to the switch mechanism isn't critical. Compensation for misalignment is provided through the operating handle mechanism's 7/16" radial adjustment. The Cutler-Hammer 10904 Motor Disconnect Switch can be used in any enclosure where the panel-to-cover depth is between 5¾" and 20¾". External operating mechanisms are also available for type F, G, J, K, KL, and L circuit breakers. For further information write for Bulletin 10904-B-249. Cutler-Hammer Inc., Milwaukee 1, Wisconsin.

CONTROL PANEL CORPORATION SUPPLIES HYDRAULIC PRESSURE GENERATOR CONTROL

One of thirty hydraulic pressure control units supplied by the Control Panel Corporation equipped with Cutler-Hammer Components.

During the past five months the Control Panel Corporation of Chicago, Illinois, has supplied a large number of these compact, NEMA 12 enclosed hydraulic pressure generator control units. The control units are used in conjunction with high speed riveting on a mass production assembly line. Typical of the control equipment used on high volume production machinery, every effort was made in the choice of the components to insure dependable, trouble-free operation.

Mr. H. A. Hart, President of the Control Panel Corporation, reports: "It has been our experience the proper performance of any machine powered by electric motors depends directly upon the control equipment used . . . no machine can be more dependable than the

Mr. H. A. Hart

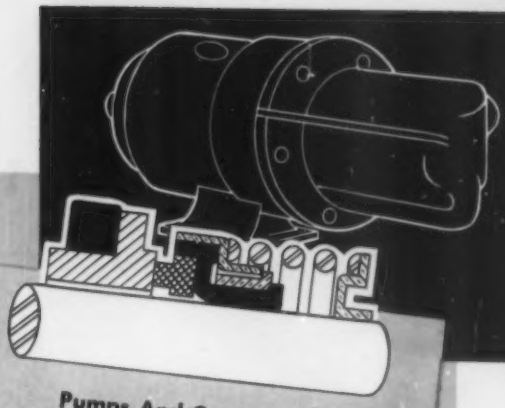
control which directs and protects it. This is why we and many of our customers consider a component's record of performance an important factor when selecting the components to be used in the controls we supply."

PANEL BUILDERS HANDBOOK SIMPLIFIES SELECTION OF ELECTRICAL COMPONENTS

This handy 70 page reference guide is specifically edited to assist design engineers and control panelbuilders in the selection of electrical control components and control accessories. Every effort was made to make this book as concise as possible, and yet it includes such vital information as wiring diagrams, dimension drawings, ratings, ordering information, and a maintained price list. Address your request for your personal copy of Bul. EE120-B-249 on your company letterhead. Cutler-Hammer Inc., Milwaukee 1, Wisconsin.

Machine Tools And Power Transmission Equipment

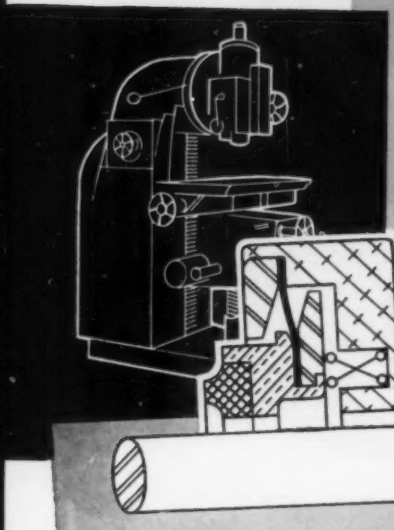
STYLE GU — A packaged sealing unit containing both rotating and stationary seal faces enclosed in metal housing. Stock sizes for shafts .250 through 4.000.



Pumps And Compressors

ROTO-FLEX — Rugged flexibility. Only 3 parts. Single or double units. Stock sizes for shafts .250 through 4.000.

STYLE RFO — A specially designed Roto-flex seal, for installation outside the stuffing box. Stock sizes for shafts .250 through 4.000.



Heavy Machine Tools

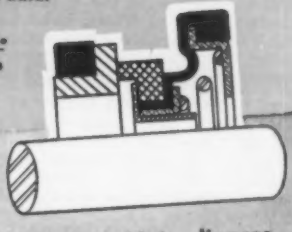
STYLE DPC — A high-speed, carbon-faced seal, for more compact installation in heavy industrial machinery. Stock sizes for shafts .250 through 4.000.

A Complete Line
GITS SHAFT SEALS
For Every Application

These modern, mechanical, face-type seals are carried in stock — to save you time and money. Write for detailed data.

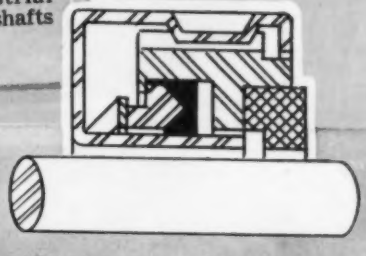
GITS BROS. MFG. CO.
1838-A South Kilbourn Avenue • Chicago 23, Illinois

Specialists In Lubricating Devices And Shaft Seals For Almost Half-A-Century



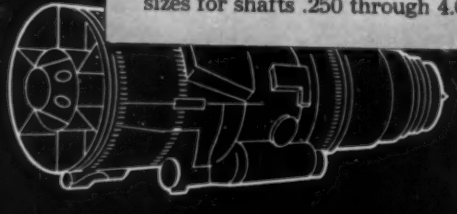
Household Appliances

STYLE SGU—A factory-assembled unit-type seal for the small-budget user. Stock sizes for shafts .250 through 1.000.



Aircraft Engines And Accessories

STYLE HH — Absolute minimal space (both radial and axial) under extreme conditions of temperature, pressure and seal face surface speed. Features pressure balance when fluid pressure is applied internally or externally. Stock sizes for shafts .250 through 4.000.



let your imagination run wild

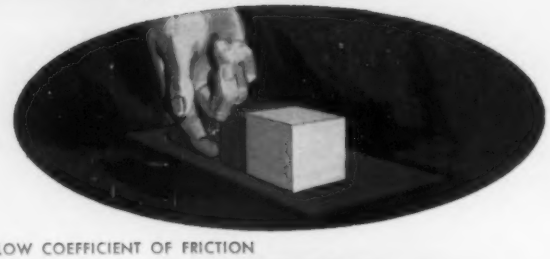
with this coating

EMRALON . . . Acheson's revolutionary new dispersion "opens the door" to a host of "restricted" applications

Five years in development, 'EMRALON' surface coatings now make possible the application of Du Pont Tetrafluoroethylene (TFE) to heat sensitive materials such as aluminum, rubber, wood and plastic. Applied by spray, these versatile resin-bonded lubricating films exhibit the low-friction properties of the TFE pigment together with the durability of their specially-selected binders. Thus, hundreds of potential uses which heretofore were impractical because of the high fusing temperature of other processes, can now be reconsidered as workable applications.

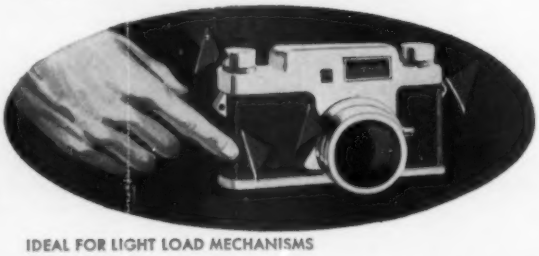
First in the Acheson family of TFE dispersions is 'EMRALON' 310,* employing a phenolic binder. Requiring a one-hour cure at only 300°F., it provides an unparalleled combination of low-friction coefficient, toughness, flexibility, adhesion and corrosion resistance. Substrates even more sensitive to temperature, or those where a bake cure is not practical, can be coated with 'EMRALON' 320† air-drying counterpart to 'EMRALON' 310.

Evaluate 'EMRALON' 310 or 320 in your plant and be among the first to "open the door" to new design possibilities. Send for an introductory package complete with data sheet. Enough to coat 5,000 sq. in. of surface is yours for $4.25 prepaid ($4.50 west of the Rockies). Write today.



LOW COEFFICIENT OF FRICTION

MAY BE APPLIED TO HEAT-SENSITIVE MATERIAL



IDEAL FOR LIGHT LOAD MECHANISMS

Acheson Colloids Company
Port Huron, Michigan

Gentlemen: Your new 'EMRALON' surface coatings suggest themselves as possibilities for a current design problem. Send an introductory package to me promptly.

- ☐ 'EMRALON' 310 (bake type)
- ☐ 'EMRALON' 320 (air-dry)
- ☐ Bill me on Order No._____
- ☐ Check enclosed
- ☐ Please have your service engineer call:

NAME: TITLE:

COMPANY:

ADDRESS:

CITY: STATE:

APPLICATION:

*'EMRALON' 310 is manufactured under exclusive license from E.I. du Pont de Nemours & Co. (Inc.) under U. S. Patent 2,825,706. Not licensed for use or for sale for use in providing electrical insulation.
†'EMRALON' 320 — Patent applied for

ACHESON *Colloids Company*
PORT HURON, MICHIGAN
A division of Acheson Industries, Inc.
Also Acheson Industries (Europe) Ltd. and affiliates, London, England

KL—A VERSATILE, RELIABLE, LOW COST P&B RELAY

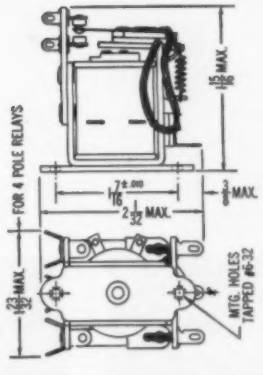
for communications and automation

ECONOMY and versatility distinguish our KL series relays. Contact arrangements are available up to 4 pdt in either AC or DC versions. Sensitivity of 100 milliwatts per movable arm is available.

Stationary contacts and terminals are mounted on a phenolic front of high dielectric strength, thus adding to the utility of the relay. Conveniently located terminals and easy-to-mount base greatly simplify installation on long production runs.

KL relays may be hermetically sealed or furnished in metal dust covers.

This is one of a "family" of fine P&B relays. Others, with similar configurations but various electrical and switching capacities, are shown below. Write or call for more information or see the complete P&B catalog in Sweet's Product Design File.



KL ENGINEERING DATA

GENERAL: Breakdown Voltage: 500 volt rms, 60 cycle between all elements standard 4 pole relay; 1500 volts rms, 60 cycle on special 3 pdt relay.

Temperature Range: −45°C. to +85°C.

Pull-in: Approx. 75% of nominal dc voltage.
Approx. 78% of nominal ac voltage.

Terminals: Pierced solder lugs for two #20 AWG wires.

Enclosures: Metal can 2⅝" high x 2⅛" long x 2 11/32" wide with octal plug or multiple solder header.

CONTACTS: Arrangements: up to 4 pdt.

Material: ⅛" dia. gold-flashed silver. (Others available.)

Load: 5 amps @ 115 volts, 60 cycle resistive loads.

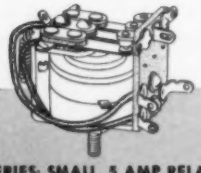
COILS: Resistance: 60,500 ohms max.

Power: 100 milliwatts per movable arm.

Duty: Continuous; coils will withstand 6 watts @ 25°C.

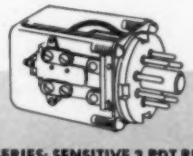
Voltages: up to 110 volts dc.
up to 230 volts ac.

P&B STANDARD RELAYS ARE AVAILABLE AT YOUR LOCAL ELECTRONIC PARTS DISTRIBUTOR



KR SERIES: SMALL, 5 AMP RELAY

Ruggedly constructed for long life and dependability. Available up to 3 pdt.

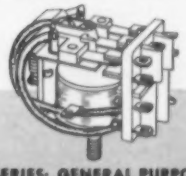


KCP SERIES: SENSITIVE 3 PDT RELAY

For plate circuit applications requiring low cost, sensitive relay. Polyethylene dust cover.

KT SERIES: ANTENNA RELAY

Insulated to minimize RF losses. Designed to switch 500 watts RF input to 300 ohm line.



KA SERIES: GENERAL PURPOSE

Compact, light-duty relay. U/L approved. Meets 1500 volts rms breakdown requirement.

POTTER & BRUMFIELD INC.

PRINCETON, INDIANA • SUBSIDIARY OF AMERICAN MACHINE & FOUNDRY COMPANY

FAST! – *up to 200 cps*

SENSITIVE! – *low as ±2.5 milliwatts*

NEW CLARE Type HGS Mercury-Wetted Contact Relay

IDEALLY SUITED TO HIGH SPEED SWITCHING DEVICES

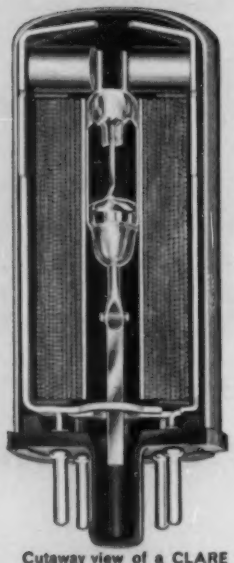
The Type HGS Relay is a new variety of CLARE Mercury-Wetted Contact Relay, developed to meet the needs of modern design engineers for faster and more sensitive relays. The HGS Relay is especially suited to all types of high-speed switching devices, over-voltage and overload protection devices and high-power chopper applications.

Operating speeds may be up to 200 cps or more. Sensitivity may be as low as ±2.5 milliwatts for a bi-stable adjustment, as low as 5 milliwatts for a single-side-stable adjustment. Contact rating is 2 amperes, 500 volts, with a limit of 100 volt-amperes.

Supplements Clare HG and HGP Relays

The new CLARE Type HGS Relay will not supplant the revolutionary Types HG and HGP. It will supplement these relays in applications which require higher speed or greater sensitivity.

The Clare Type HGS is similar to the Types HG and HGP except that the HGS is always biased with permanent magnets. These are adjusted to single-side-stable or bi-stable operation.



Cutaway view of a CLARE Type HGS Relay. Mercury-wetted contact switch is sealed in glass and surrounded by the operating coil. Biasing magnets are attached to the upper ends of the side plates.

ELECTRICAL FEATURES

Long Life: Over one billion operations at rated load.

Operation Speed: Up to 200 cps with consistent performance. Higher if some variation is tolerable.

High Sensitivity: 5 milliwatts for single-side-stable adjustment; ±2.5 milliwatts for bi-stable adjustments.

Stable Operation: 0.1 millisecond maximum operating time variation.

Freedom from Chatter: Absolutely NO CONTACT BOUNCE.

Low, Stable Contact Resistance: Initial contact resistance, 25 to 50 milliohms, does not vary by more than 1 or 2 milliohms during life of contacts.

Low Ratio Coil Inductance: Low inductance-to-resistance ratio of coil suits relay well for transistor-drive applications.

MECHANICAL FEATURES

Conveniences: Small, light-weight; plugs in like vacuum tube; completely protected from atmospheric conditions; contacts cannot wear, weld, stick or chatter; tamper-proof; requires no maintenance.

Durability: Easily withstands normal handling and transportation shocks.

Send for CLARE Sales Engineering Bulletin No. 125 for complete information on the new Type HGS Relay. Bulletins 120 and 122 describe HG and HGP Relays. Write: C. P. Clare & Co., 3101 Pratt Blvd., Chicago 45, Illinois. In Canada: C. P. Clare Canada Ltd., 2700 Jane Street, Toronto 15. Cable Address: CLARELAY.

CLARE RELAYS

FIRST in the industrial field

HOW TO SOLVE PRODUCT DESIGN PROBLEMS WITH

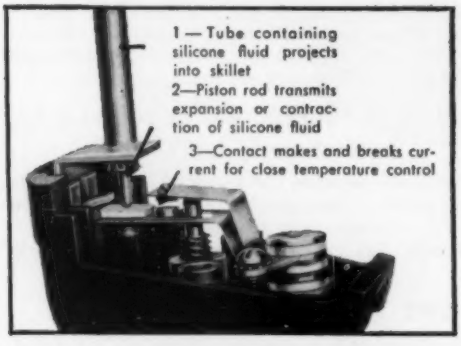
SILICONE IDEAS

Silicone rubber for wire insulation adds improved physical properties to excellent electrical properties

Always valued for its high performance electrical characteristics at high temperatures, silicone rubber insulation for wire now has improved physical properties. A true elastomer, GE silicone rubber is suitable for thin wall (.012") wire construction, does not tend to cold flow under clamps, can be bent double without cracking, stays flexible down to —150°F.

Even when exposed to a direct flame, G-E silicone rubber still insulates, won't release toxic fumes. Withstands current overloads of 300%-400%, provides a safety margin for intermittent high temperature operation in Class B equipment. Excellent dielectric strength stays high throughout life; service to 500°F—and to 600°F for shorter periods. Features high ozone, moisture and weather resistance, long shelf life.

No damage occurs when you wrap silicone rubber insulated wire around a hot soldering iron, proof of silicone rubber's remarkable heat resistance.


1—Tube containing silicone fluid projects into skillet
2—Piston rod transmits expansion or contraction of silicone fluid
3—Contact makes and breaks current for close temperature control

New appliance thermostat uses silicone fluids for faster, closer temperature control

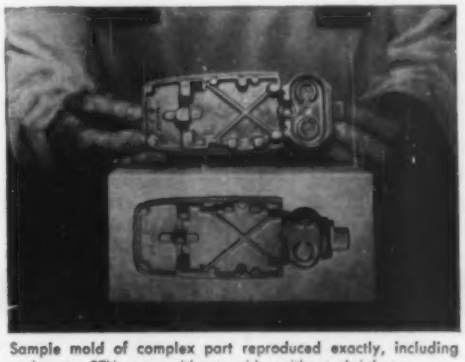
General Electric silicone fluids, because of their high coefficient of expansion and thermal stability, make possible the extremely accurate temperature control provided by the new G-E appliance thermostat. Reaction time is faster than with bimetallic elements; cost fully competitive.

This is only one example of creative engineering with G-E silicone fluids. Their unique properties—small change in viscosity with temperature, chemical inertness, excellent resistance to shear, oxidation and high-temperature breakdown—make them ideal for such applications as dash pots, vibration dampers, heat transfer fluids, fluid transmissions, etc.

New silicone rubber cures without heat, keeps physical and electrical properties to 600°F

Need to seal or caulk metal glass or plastic parts? Encapsulate or pot delicate assemblies? Mold silicone rubber parts in place? Patch or repair rubber parts? Need a flexible, heat resistant, accurate, self-releasing mold for low-cost plastic tooling or model making?

New G-E RTV (room temperature vulcanizing) silicone rubber will do all this and more. Cures without voids at room temperature in any time you select up to 48 hours. Stable up to 600°F. Tough, elastic, bonds well to primed surfaces. Has good resistance to fluids and fuels. Viscosities from very pourable to spreadable. Solvent free—shrinks less than 0.2% while curing. Write for technical data. Samples available for evaluation—just give us a brief description of your application.



Sample mold of complex part reproduced exactly, including undercuts. RTV cures without voids, without shrinkage.

Write for more information

OPERATION upturn GENERAL ELECTRIC

GENERAL ELECTRIC

Silicone Products Department, Waterford, New York

Section D10A1, Silicone Products Dept.
General Electric Company, Waterford, N. Y.

Please send me further data on:

☐ Silicone Rubber Wire Insulation ☐ Silicone Fluids
☐ Silicone RTV Rubber

Name_____ **Title**_____

Company_____

Address_____

City_____ **Zone**_____ **State**_____

←CIRCLE 132 READER SERVICE CARD

CIRCLE 133 READER SERVICE CARD

Slots (or corrugations) prevent Fastener from turning.
Sheet remains flush on opposite side. No swaged rim projects.
Clinching ring squeezes sheet material around back-tapered shank, securely locking Fastener.

PEM

The ORIGINAL Self-Clinching Fastener

Fifteen years ago Penn Engineering and Manufacturing Company introduced the self-clinching fastener, providing load-bearing threads in a wide range of—steel, aluminum, brass and copper sheets, "too thin to thread."

THE ANSWER TO PRODUCTION FASTENING

This unique, exclusive design was immediately recognized as the answer to production fastening by leading manufacturers of aircraft and missiles, automotive, electronic and communication equipment, business machines, farm machinery, electrical appliances, transportation equipment, vending machines, home appliances, etc. Stimulated the cost-conscious sheet metal assembly techniques utilized, today, by many of these manufacturers.

INSTALLED BY A SQUEEZE *With the Greatest of Ease* (without special tools)

Users tell us that—because the shank of PEM nuts acts as their own pilot . . . because, being round, they require no indexing . . . because they require no special tools . . . because several may be pressed into place in a single operation

THEY SAVE THEIR COST MANY TIMES OVER

. . . in time, labor and special equipment. That PEM nuts are one of the most profitable items in the assembly line.

Today, PEM Self-Clinching Nuts are made in six types for sheet thicknesses from .032 and up—in steel (with various rust resistant finishes), stainless steel, monel and aluminum. Sizes range from #2 to ¾". Also made as Blind Fasteners for pressure seal applications.

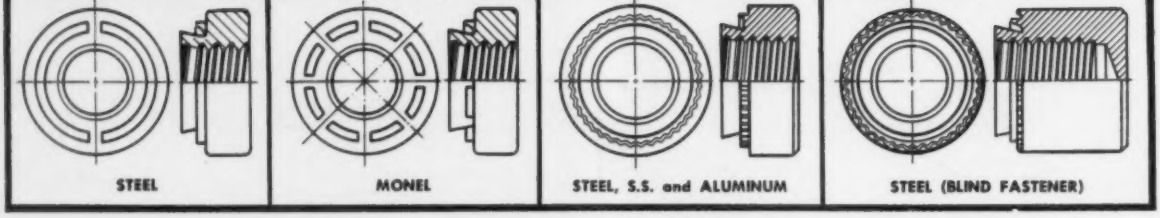
For complete information, write for Bulletin No. CL356 and sample for test.

HIGH TORQUE AND PUSH-OUT RESISTANCE

. . . greatly in excess of assembly handling and screw torquing requirements, insure smooth, fast, uninterrupted fastening procedure. In service, under working load and vibration, torque and push-out resistance are not reliability factors, since the screw is always pulling the PEM Nut toward the sheet into which it is fastened.

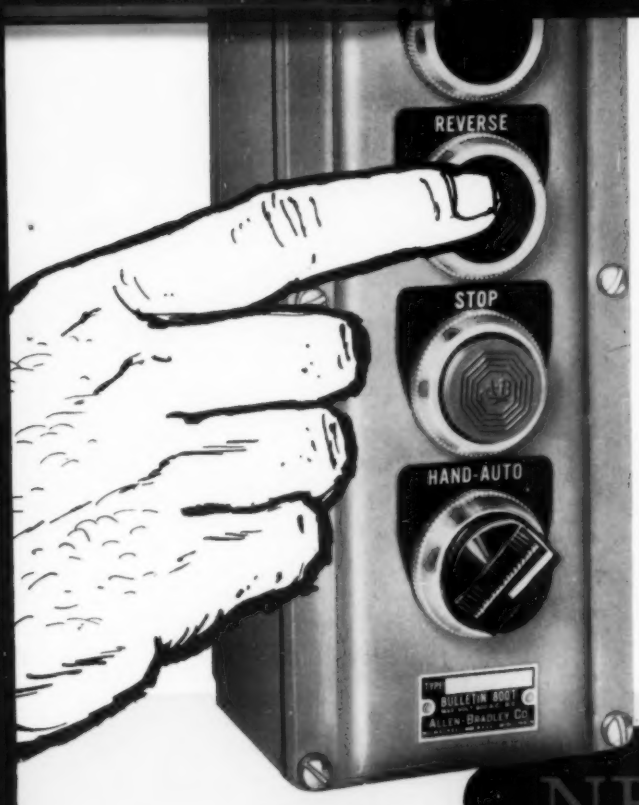
The smooth *reverse* side of the sheet, with no swaged rim projecting, permits flush-tight assembly without need for clearance hole in attached part.

SIX TYPES OF PEM SELF-CLINCHING FASTENERS ANSWER MOST ALL REQUIREMENTS



PENN ENGINEERING & MANUFACTURING CORP.

DOYLESTOWN • PENNSYLVANIA



A-B Reliable Control Units

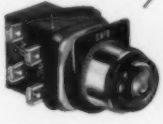
for every industrial application

Among the many hundreds of Allen-Bradley push button and control units, you are certain to find the types best suited to your particular needs. The seven units shown below are a few of the latest additions to the Allen-Bradley *quality* line of control units.

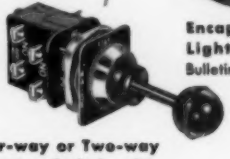
All Allen-Bradley control units—standard duty, heavy duty, and oiltight—have double break, silver alloy contacts—to assure reliable operation. Simple constructions and generous wiring room are outstanding features. Insist on Allen-Bradley control units for *all* of your equipment—you can't go wrong!

NEW

Illuminated Push Button. Combines pilot light and push button in one unit. Oiltight Bulletin 800T.



Push-to-Test Pilot Light. Oiltight Bulletin 800T.



Four-way or Two-way Selector Switch. Oiltight Bulletin 800T.

Encapsulated Pilot Light. Heavy Duty Bulletin 800.

Encapsulated Pilot Light. Oiltight Bulletin 800T.

Time Delay Push Button. Delay is adjustable from 0.5 second to 5 seconds. Oiltight Bulletin 800T.

Double Circuit Push Button. Has 2 N.O. or 2 N.C. contacts. Oiltight Bulletin 800T.

STANDARD DUTY CONTROL STATIONS

HEAVY DUTY CONTROL STATIONS

OILTIGHT CONTROL STATIONS

ALLEN-BRADLEY OFFERS the most complete line of standard duty, heavy duty, and oiltight control stations on the market. Send for Publication 6090 today.

1-59-MR

ALLEN-BRADLEY

MOTOR CONTROL

QUALITY

Allen-Bradley Co., 1316 S. Second St., Milwaukee 4, Wis.
In Canada: Allen-Bradley Canada Ltd., Galt, Ont.

A new "quality" standard for small REVERSING DRUM SWITCHES

A-B QUALITY

GOOD-LOOKING AND GOOD "FEELING" DIE CAST HANDLE

EASILY ACCESSIBLE MOUNTING HOLES

MERELY LOOSEN SCREW AND SLIDE PLATE to change from momentary to maintained contacts —or vice versa

INDEPENDENT SWITCH MOUNTING prevents misalignment

HEAVY CONTACT SURFACES for long operating life

TWO CONDUIT OPENINGS

WRAP-AROUND COVER gives complete access to drum

SINGLE SCREW COVER MOUNTING —screw cannot fall out

ACCESSIBLE SCREW TERMINALS for front wiring

RAISED EDGE for base mounting without spacers

maximum rating 2 horsepower

NEW OILTIGHT COVER PLATE FOR CAVITY MOUNTING

Bulletin 350 Reversing Switch can be furnished with oiltight cover plate with rubber gasket seal for cavity mounting in a machine base.

This *all-new* Allen-Bradley reversing drum switch was designed to keep pace with the mechanical beauty designed into so many of the modern machine tools.

The Bulletin 350 reversing switch is equivalent to a three-pole, double throw switch . . . and can be used with d-c motors; or single phase, two phase, or three phase a-c motors.

Investigate the Bulletin 350 . . . the *new leader* of its class . . . in appearance, ease of installation, and operating life. An Allen-Bradley *quality* switch . . . in every sense of the word. Send for descriptive bulletin.

ALLEN-BRADLEY

MOTOR CONTROL

QUALITY

Allen-Bradley Co., 1316 S. Second St., Milwaukee 4, Wis.
In Canada—Allen-Bradley Canada Ltd., Galt, Ont.

1-59-MR

another

NEW BOOK

with that

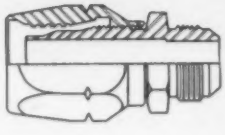
Eastman

LOOK

36 pages on medium to low pressure hydraulic hose and tube assemblies

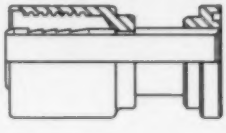
REUSABLE COUPLINGS FOR RUBBER COVER HOSE

Exclusive Eastman design directs flow of hose into machined recesses of insert and coupling body. Doubles the hold, assuring longer service. Pages 26 & 27.



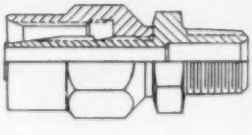
PERMANENTLY ATTACHED FLANGE HEAD COUPLINGS

Attractive, low cost permanent hose attachment—plus convenience of split-flange head couplings with 0 to 90° stems permitting full 360° positioning. Pages 20 & 21.



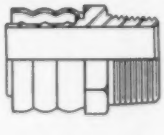
REUSABLE COUPLINGS FOR COTTON COVER HOSE

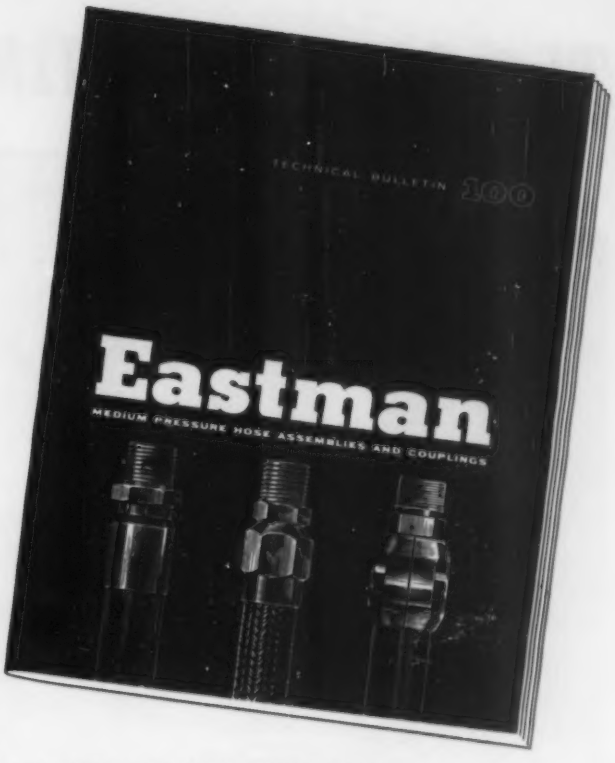
Eastman engineered two-piece coupling can be assembled without stripping hose. (Can also be used on thin rubber cover hose without removing cover.) Full details on pages 24 & 25.



PERMANENTLY ATTACHED COUPLINGS FOR SUCTION HOSE

For use on spiral wire return lines. Maximum orifice permits rapid return of hydraulic fluid assuring adequate supply from lever to load for top payload power. See page 31.





ARRANGED FOR YOUR CONVENIENCE TO MAKE IT EASIER FOR YOU TO:

Locate your required assemblies
Determine the proper couplings
Specify according to pressure

EASTMAN'S New Technical Bulletins on Hydraulic Hose and Tube Assemblies are the talk of the trade!

Here's the second in the series which you will want to send for right away—Technical Bulletin No. 100 on Medium to Low Pressure Assemblies. Working Pressures range from 3000 psi to 75 psi (for return suction lines).

Easy-to-use tables arranged opposite dimensional drawings for the entire Eastman line of Couplings: Permanently Attached, Clamp Type, Flange Type and Reusable—for One Wire Braid Rubber Cover, Cotton Cover and Suction Hose—plus necessary adapters and tube fittings.

This is a necessary companion to the first in Eastman's New Series of Bulletins—No. 200, on High Pressure Assemblies. Be sure that your personnel is supplied with copies of *each* of these modern bulletins.

Write today! Send the quick service coupon below.

EASTMAN MFG. CO., DEPT. PE-1, MANITOWOC, WISCONSIN

Please send me.....copies of Bulletin 100 on Medium to Low Pressure Eastman Assemblies for 1-wire braid hose.

Please send me.....copies of Bulletin 200 on High Pressure Eastman Assemblies for 2-wire braid hose.

Also.....copies of Bulletin 500 on Adapters and Adapter Unions.

Name _____ **Title** _____

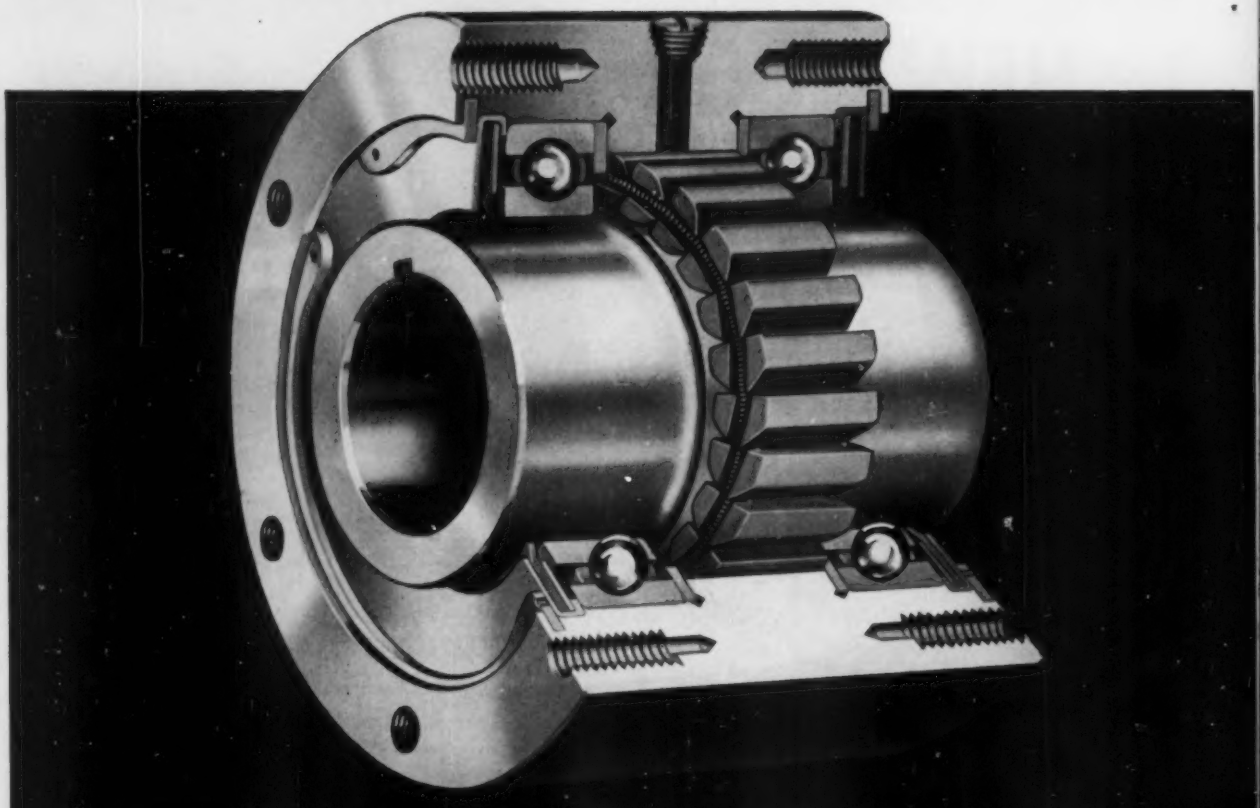
Company _____

Address _____

Eastman
first in the field

SAFEGUARDING AMERICA'S LIFELINES OF MOBILE POWER

The OVER-RUNNING CLUTCH With

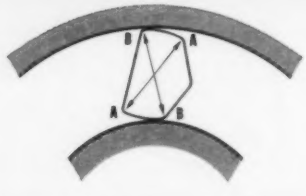


OVER-RUNNING · INDEXING
BACKSTOPPING

STANDARD CLUTCHES FOR ORIGINAL EQUIPMENT NEEDS

Formsprag Clutches are used throughout industry, from business machines to aircraft, in bore sizes from ¼" to 12". Several informative bulletins available, including: "Design Considerations for High-Speed Over-running Clutches," "Ten Design Ideas", "Seven Ways to Reduce Space and Costs", plus the complete Formsprag catalog. Write for any one or all.

HERE'S



The Formsprag clutch consists of a full complement of shaped sprags, or wedges, located between concentric inner and outer races. Power is transmitted from one race to the other by the wedging action of the sprags. Each sprag is so shaped that dimension AA is greater than BB. Rotation of one race in the "driving" direction causes the sprags to wedge, transmitting torque in full from one race to the other.

Greatest Torque
Per Inch – Per Ounce

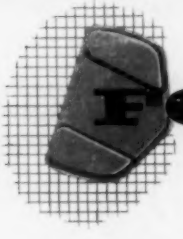
Modern power transmission design demands the utmost torque capacity in an absolute minimum of space. That's why designers in every field specify Formsprag clutches . . . the *modern* way to transmit power on over-running, back-stopping and indexing applications.

Along with highest possible torque capacity for its size and weight, every Formsprag clutch offers such additional benefits as internal simplicity (just four basic parts), no measurable backlash, light weight, compactness, extreme precision and long, trouble-free life. Formsprag's exclusive, patented principle is unlimited in application, yet this full-complement sprag type clutch is extremely simple in design and operation.

There is a size and model Formsprag clutch for every application. Standard models include sleeve bearing, ball bearing, miniature, and large bore backstop types. These are shown in the current Formsprag catalog, complete with specifications, performance data and design suggestions. Ask your Formsprag distributor, or write direct for your copy. For special applications, Formsprag engineers will recommend a modified standard or design a special. Send details of your requirements.

FORMSPRAG COMPANY
23607 Hoover Road, Dept. 100
Warren (Detroit), Michigan

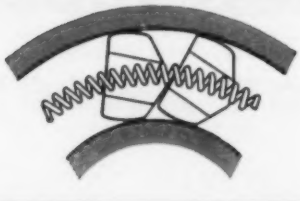
In Canada: Renold Chains Canada, Limited
In United Kingdom: Renold Chains, Limited
Distributors in Principal Cities

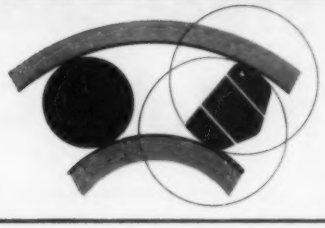


FORMSPRAG CLUTCHES

World's Largest Exclusive Manufacturer of Over-running Clutches

HOW IT WORKS

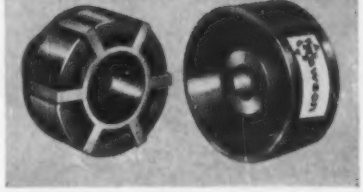




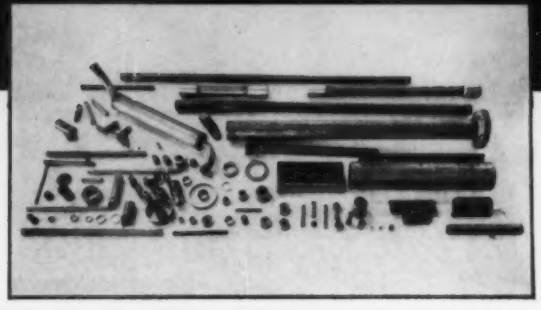
An expanding coil spring keeps the sprags in light contact with both inner and outer races. There is thus no lost motion, the driving torque being instantaneously transmitted between races. The Formsprag Clutch is so designed that it will transmit a greater torque in relation to its size and weight, than any other comparable type of clutch . . . specify Formsprag on over-running, back-stopping and indexing applications.

Forcing a ball or roller into a curved, wedged space is an old over-running clutch principle. The sprag is, in effect, a "roller" of increased diameter with greater contact surface in a given annular space. Formsprag Clutches engage at constantly changing contact points. Clutch life is prolonged and backlash eliminated. Also, with the inclined surfaces discarded, more sprags can be inserted to increase torque capacity.

FOR NO-LOAD STARTS



Specify Rawson Automatic Centrifugal Clutches and Clutch Couplings. They protect the prime mover, eliminate need for costly reduced voltage starting equipment, permit use of less expensive smaller motors to start high inertia loads. Completely automatic and entirely mechanical in operation. Rawson clutches provide full overload protection, never need adjustment. Write for the new Rawson Clutch Catalog now.



Seven-million miles of street and industrial sweeping in 700 cities have proved rugged dependability of Wayne Manufacturing Company's equipment. Here is the final assembly line in its plant. Large horizontal tube on sweeper is jack shaft housing for gutter broom drive. Wayne makes 300 parts from Pittsburgh Steel's Seamless cold-drawn tubing (see inset at right). That's how . . .

Pittsburgh Steel Seamless Tubes Help Wayne Make Clean Sweep

Nobody knows how many brooms it would take to keep the world clean. But out in Pomona, California, Wayne Manufacturing Company is ready to tackle the job with a complete line of power sweepers.

Founded only ten years ago, the Wayne Company has grown rapidly until today it produces more street and industrial power sweepers than all others in the field combined. Wayne is the only power sweeper produced by assembly-line operation.

Largest Wayne sweepers handle up to four cubic yards of debris at a time. Their assembly requires more than 1,000 complicated and accurately manufactured steel parts.

• **300 Key Parts**—Of these, more than 300 key items are fabricated from Pittsburgh Steel Company's Seamless Tubing in both carbon and alloy grades in sizes ranging from one-quarter inch to six inches in diameter. It is furnished cut to length and ready for fabrication by Baker Steel & Tube Company of Los Angeles, a Pittsburgh Steel distributor.

This service helps speed Wayne production, keeps inventories down and is typical of service rendered by all Pittsburgh distributors.

"Requirements for the parts produced from Pittsburgh tubing are exacting," says Wayne production vice-president, Roy E. Nelson. "Our sweepers are doing big jobs, many of them operating on a 24-hour schedule, and we

CIRCLE 139 READER SERVICE CARD

must have a tough, dependable product in the critical spots to take this constant heavy beating."

That is why Wayne uses Pittsburgh Seamless Tubing in critical components such as rugged axle assemblies, torque housings, drive shafts, hydraulic actuating cylinders—even small fittings.

Over the years, Wayne production men have found Pittsburgh tubing has the surface finish, close size tolerance and concentricity which minimize the amount of machining that must be done. Its uniformly high physical properties and internal soundness provide the stamina necessary for long, trouble-free service.

• **Ease of Fabrication**—The machinability and weldability of Pittsburgh tubing make for ease of fabrication, keep scrap losses down, and assure uniform parts—all important factors in keeping production lines moving smoothly.

As an aid to industrial good housekeeping, Wayne produces smaller power sweepers for use inside and outside plants. Its newest line is the Autoette series which includes the glamorous "Golfmobile" and the family "Cruise About." Three industrial models provide efficient transport of personnel and materials in sprawling plants.

These industrial sweepers and Autoettes also depend upon Pittsburgh Steel tubing for parts in key assemblies.

Manufacturers find the uniformly high quality of Pittsburgh cold-drawn steel seamless tubing and excellent service from Pittsburgh distributors are big assets in improving products and operating efficiency. To enjoy these benefits get in touch with the representative nearest you.

Pittsburgh tubes withstand torque and fatigue in main and auxiliary drives on Wayne sweepers.

Machinability and weldability of Pittsburgh tubes are vital in making this shaft which goes into differential assembly. Short tube is welded over longer, smaller diameter tube, then machined to tolerance of .001 inch to assure perfect fit in housing.

Rugged front axle assembly of Wayne sweeper made from Pittsburgh tubes carries most of weight of machine and up to four cubic yards of debris. It must withstand road shocks and constant heavy-duty operation.

Pittsburgh Seamless Distributors

Baker Steel & Tube Company
Los Angeles, California

Chicago Tube & Iron Company
Chicago, Illinois

Cleveland Tool & Supply Co.
Cleveland, Ohio

Drummond McCall & Co., Ltd.
Montreal, Quebec, Canada

Edgcomb Steel Company
Philadelphia, Pennsylvania

Gilmore Steel & Supply Co.
San Francisco, California

Earle M. Jorgensen Co.

Perry Kilsby, Inc.
Los Angeles, California

Mapes & Sprowl Steel Co.
Union, New Jersey

Metal Goods Corporation
St. Louis, Missouri

Miller Steel Company, Inc.
Hillside, New Jersey

A. B. Murray Co., Inc.
Elizabeth, New Jersey

C. A. Russell, Inc.
Houston, Texas

Ryerson, Joseph T. & Son, Inc.
Chicago, Illinois

Solar Steel Corporation
Cleveland, Ohio

Steel Sales Corporation
Chicago, Illinois

Tubular Sales
Detroit, Michigan

Ward Steel Service Company
Dayton, Ohio

Pittsburgh Steel Company

Grant Building • Pittsburgh 30, Pa.

District Sales Offices

Atlanta, Chicago, Cleveland, Dallas, Dayton, Detroit, Houston, Los Angeles, New York, Philadelphia, Pittsburgh, Tulsa, Warren, Ohio

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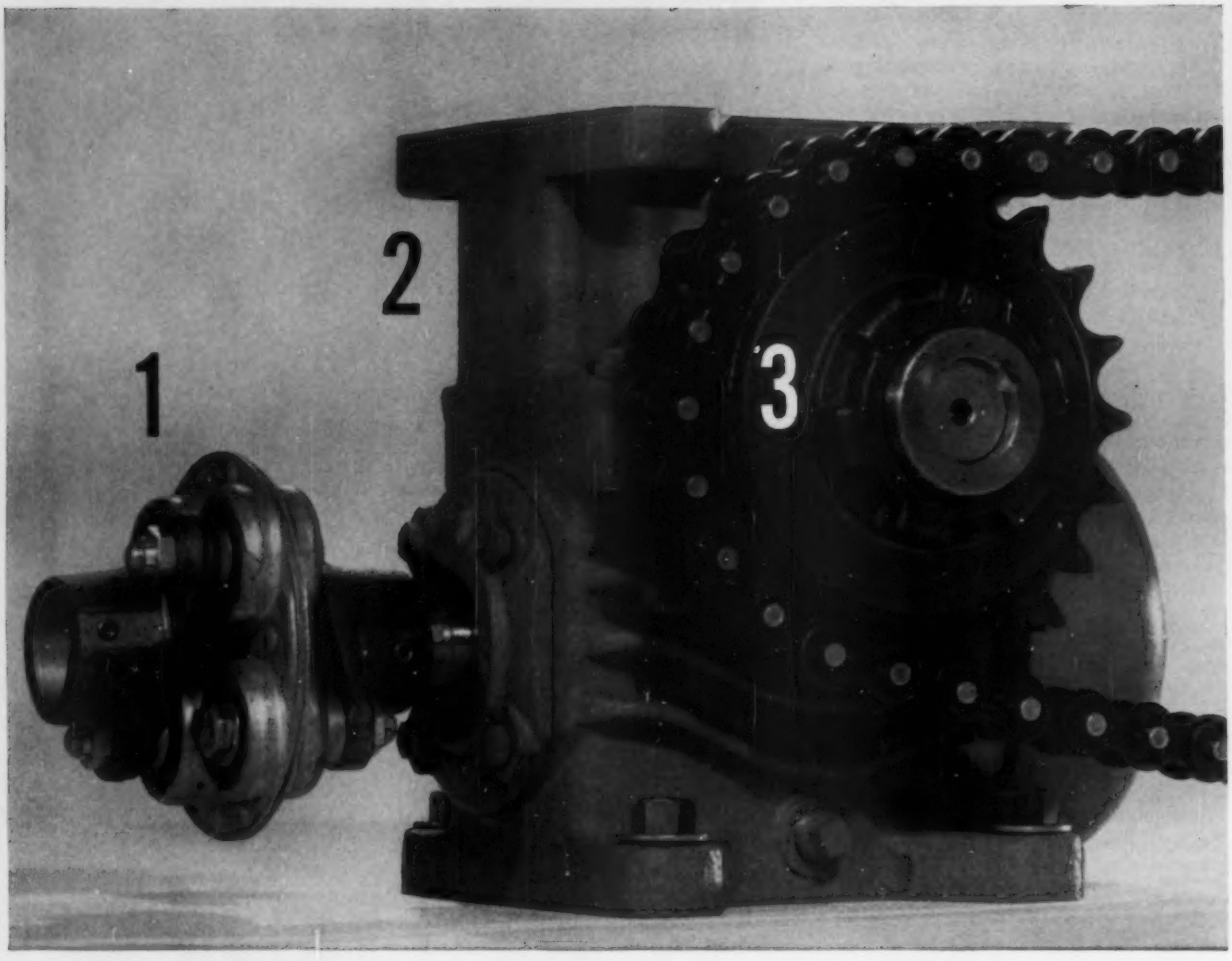

Morse's entry into the speed reducer field means:

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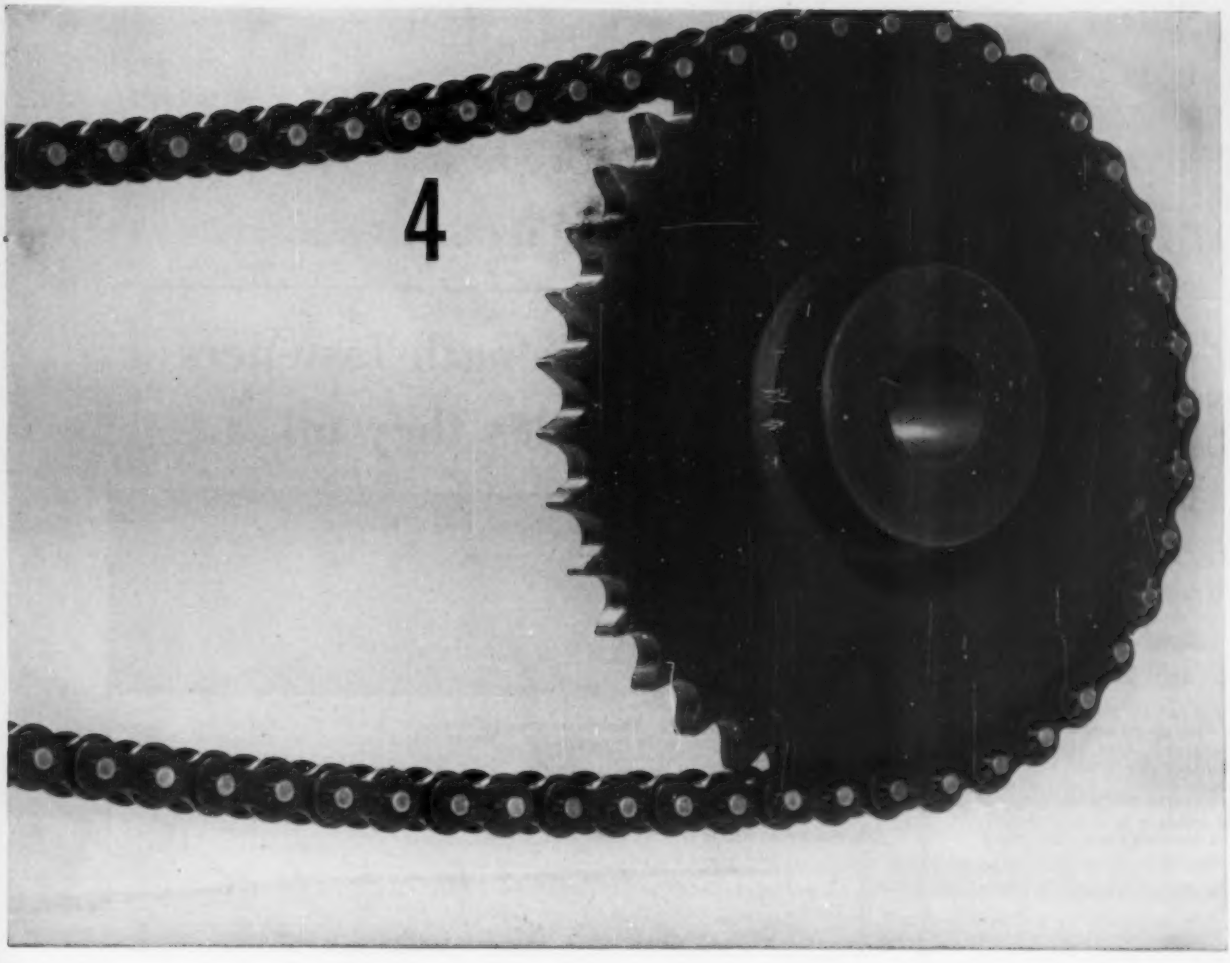

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Technical-ities

By John S. Davey

Quick facts on cold heading

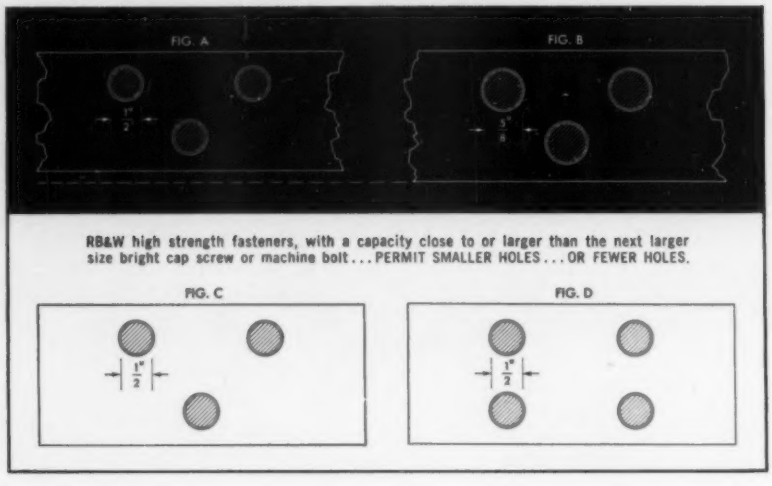
Compared to machining, cold heading gives stronger pieces at less cost. Also, the headers automatically control quality because unsound material cannot be used. While the scope of cold headers is wide indeed, it pays to design for them right at the start.

Some rules of thumb to guide you:

1. You save money after a run of 25,000 pieces (which pays for the set-up).
2. Maximum length of parts runs about 6 inches. For straight upsetting, maximum diameter is about 4½ times that of shank. (With special operations, up to 26 diameters have been achieved!)
3. Various metals and alloys are suitable. But keep carbon content in steel to under 0.45.
4. Concentric pieces are easier to form, though eccentric and serrated shapes are practical.
5. Avoid sharp corners. Allow generous radii.
6. Because upsets are usually cylindrical, oval or round shapes take less trimming than square or rectangular.
7. Hollow upsets tend to form cracks at edges of recess, so avoid them.
8. Embossing raises costs.
9. No problem heat treating short sections. But long sections are apt to be distorted.

When in doubt, contact an expert in cold heading.

How high strength fasteners affect the holes they fill



RB&W high strength fasteners, with a capacity close to or larger than the next larger size bright cap screw or machine bolt... PERMIT SMALLER HOLES... OR FEWER HOLES.

As simple a matter as the selection of fasteners can permit changes for better design... and also improve production costs and service life.

In sketch "A", for example, you see one difference from use of RB&W high strength fasteners instead of machine bolts or bright cap screws, as in "B". You use a smaller size fastener. Holes are therefore smaller. The metal section, in turn, can then be smaller for a saving in material and weight. The costlier the materials (copper bus bars as a case in point), the more significant the cost savings.

In sketch "C", fill the 3 holes with ½" high strength bolts, and you have a load capacity close to 40,000 pounds. That's the same as developed by 4 bright cap screws filling holes in Sketch D. It costs less to drill and less to fill the 3-hole design.

RB&W High Strength Fasteners are now identified by this new marking as well as 3 radial dashes. They have the proper balance between ductility and hardness required in high carbon units.

EFFECT ON PERFORMANCE AND PRODUCTION

When tightened to their full load, high strength fasteners not only *stay* tight — even under vibratory conditions — but also exert high clamping force. It has been shown that, under high compressive forces, hole areas gain extra resistance to fatigue cracks.

What's more, the high friction developed virtually locks members together, prevents slippage. Holes, therefore, need not be perfectly aligned since they can even be slightly oversized without detriment.

There's an RB&W Fastener Man ready to aid you in working with high strength bolts — in the design stage or as replacement for SAE grade 1 or 2 steel fasteners or for rivets. Write for helpful booklet DC-1, Russell, Burdsall & Ward Bolt and Nut Company, Port Chester, New York.

Plants at: Port Chester, N.Y.; Coraopolis, Pa.; Rock Falls, Ill.; Los Angeles, Calif. Additional sales offices at: Ardmore (Phila.), Pa.; Pittsburgh; Detroit; Chicago; Dallas; San Francisco.

PERSPECTIVES

in design and development . . .

Merge for R&D Gain

Some years ago Mr. Crawford Greenwalt, president of DuPont, testified before a Congressional Subcommittee on the Study of Monopoly Power . . . "I would say that not more than 1 in 20 out of our research investigations ever rings the cash register, and that in money not more than 1 out of 5 research dollars ever pays off. This means that if we risk $6 million in research on nylon, there are perhaps $24 million spent on unsuccessful ventures that must be paid for by the one that does come through." He added that the reason for acquiring various companies and manufacturing processes was "because of the needs for a broad framework of commercial experience in the chemical field against which to appraise the products of research. . . . [without this] I can assure you that the 20-to-1 ratio would be nowhere near as favorable."

Further study of the relationship between research and development and the increasing number of diversification mergers, recently made by Queens College professor M. N. Friedman, has just been published by the Senate Subcommittee on Patents, Trademarks and Copyrights. The report repeats what many economists and engineers have been saying for some time: that new products—the results of R & D—are becoming more and more important as a form of competition in industry today. Without making any proposals for government action, or new legislation, the study suggests the need to guard against concentrating R & D activity in the large companies.

In this respect Friedman harks back to a year-old report by the Attorney General—that corporations with 5000 or more employes accounted for only 40% of the total employment in manufacturing industries in 1953, but these companies employed 61% of the total number of scientists and engineers and performed 72% of total R & D undertaken in these industries.

The Attorney General said: "The disproportionate share of total industrial research and development in the largest firms may foreshadow a greater concentration of economic power in the future. An adequate supply of technical manpower is the first prerequisite to any R & D program. Such programs themselves are basic factors in the development and expansion of our business economy."

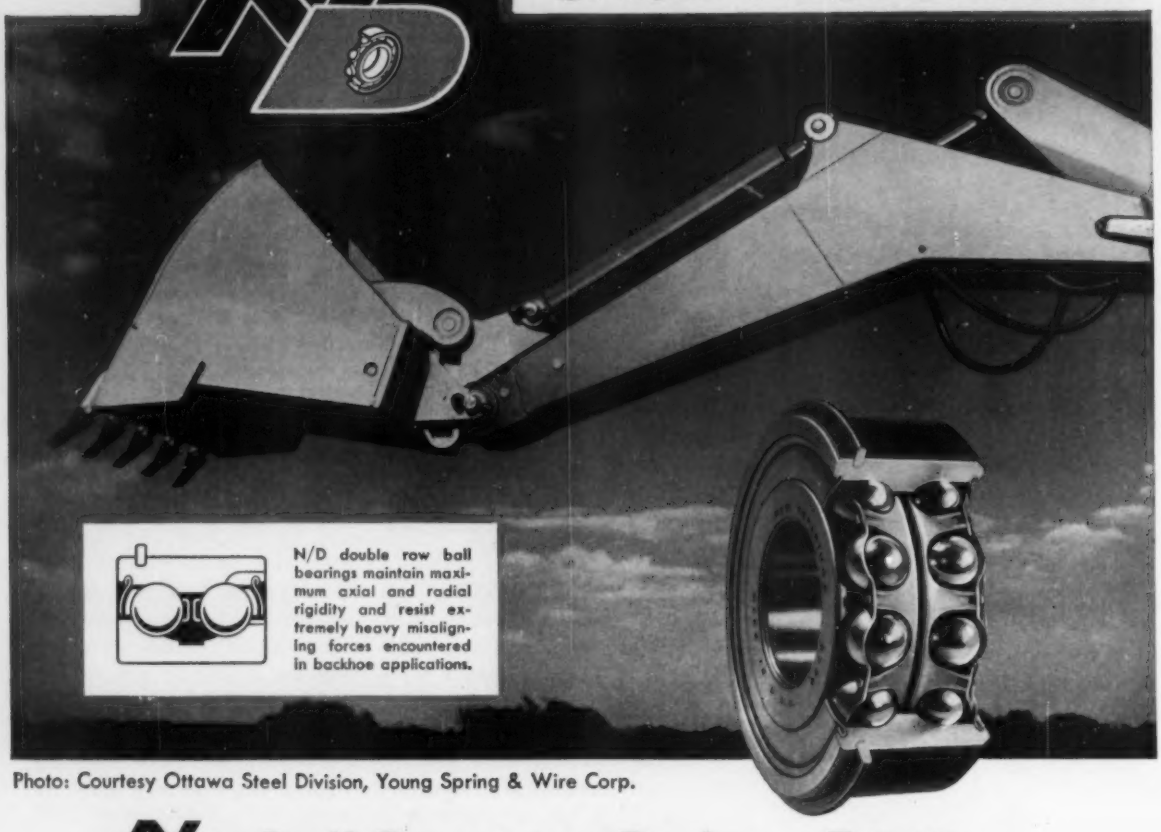
And Mergers Increase

Despite legislation in 1950 (the Celler-Kefauver amendment of section 7 of the Clayton Antitrust Act) to place a check on the increased concentration of businesses resulting from mergers, the FTC says there were more mergers in the 5 years following this amendment than in any corresponding period since 1926-30, and that the number of mergers in each year since 1950 has been higher than the year before.

Friedman suggests that a variety of motives related to R & D are present in a merger or acquisition. These are: the acquiring company may wish to obtain an established patent base plus the R & D staff in the new field it is entering; the acquiring company may be interested only in the R & D staff of the acquired company; both the acquiring and the acquired companies have the opportunity for complementary product diversification; a larger company with capital resources can commercially develop the ideas of a smaller firm; or, a company with extensive R & D facilities that can turn out a variety of products will acquire a firm with an existing market position in these fields.

—Paul Anderson

CASE HISTORIES



N/D double row ball bearings maintain maximum axial and radial rigidity and resist extremely heavy misaligning forces encountered in backhoe applications.

Photo: Courtesy Ottawa Steel Division, Young Spring & Wire Corp.

N/D Ball Bearings Reduce Friction... Up Usable Hydraulic Power In Backhoe!

CUSTOMER PROBLEM:

Increase efficiency of tractor/truck-mounted backhoe and reduce in-the-field maintenance requirements for the end customer.

SOLUTION:

N/D Sales Engineer, working with the manufacturer, recommended replacing 10 bronze bushings with factory lubricated New Departure shielded ball bearings. These New Departures eliminated arm play and loose joints . . . reduced friction to make more, useful hydraulic power available! What's more, shielded N/D ball bearings resist wear. They eliminated the need for relubrication maintenance because they're lubricated for life!

If you're working on new equipment designs, or redesigning, why not call on New Departure? New Departure's wide selection of construction and farm equipment ball bearings means there's probably a production bearing that will help you. For more information, write Department P-1.

Available through United Motors System and its Independent Bearing Distributors.

NEW DEPARTURE

DIVISION OF GENERAL MOTORS, BRISTOL, CONN.

NOTHING ROLLS LIKE A BALL

Product Engineering **HORIZONS**

January 19, 1959

EASY DOESN'T DO IT

Electromagnets in seats, and steelwool in suits—this is one seriously proposed device for keeping the space traveler from floating in space inside his rocket. All tools and small gear would be put in steel-mesh bags and similarly held. The ailing traveler—or orbiter—would transmit his symptoms by TV to a specialist, who would prescribe treatment by radio, because human malfunction could be serious.

These are among ideas proposed by a dozen military and civilian space men at recent Washington and Dallas conferences (*PE—Oct* 13 '58, p 41). Weight is of course the major problem. Explorer I cost $100,000 a pound to orbit, according to Robert D. Demoret, chief, aeronautical section, The Martin Co. He predicts only $100 a pound by 1970—so you'll be able to take an orbit vacation for $20,000, providing you can stand the boredom, the ennui, the weightlessness. But design must still stress minimum weight.

The idea of the steel-wool suit is to give you the same gravitational "feel" as you would have sitting down on earth, according to Dr. Harold Van Beckh of the Air Force Missile Development center. He also points out the need for exercise machines so the long space flight, when man is virtually weightless, will not atrophy the flier's muscles.

Dr. Otto H. Schmidt, physicist of the University of Missouri, figures that simple algae, under the strong sunlight in space, could reconvert the carbon dioxide exhaled by humans into oxygen, and meanwhile would grow fast enough so they'd provide food and moisture. Algae taste like wet cardboard, so something would have to be done about that. And to feed the algae, human wastes could be processed in a fertilizer plant. Thus the rocket ship becomes a little self-perpetuating world.

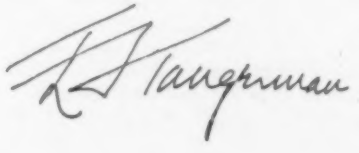
It is characteristic of our present development that we begin, at this early date, to think about human comfort, even in space flight. We have been striving for years to attain "the better life." Somewhere along the line, we converted "better" to "easier", so much of our current work is designing gadgets to make us and our lives softer.

We've practically abolished hard physical labor, and now we're trying to do the same thing with mental effort. Current criticism of our educational system is one result of this trend—we've tried to develop a painless form of education, to take the work and effort out.

The point is obvious. Muscles do not gain hardness or retain "tone" unless they're used, and used hard. Brain cells need exercise, too, or they become just skull filler. The student who doesn't have to think becomes the grown-up who can't.

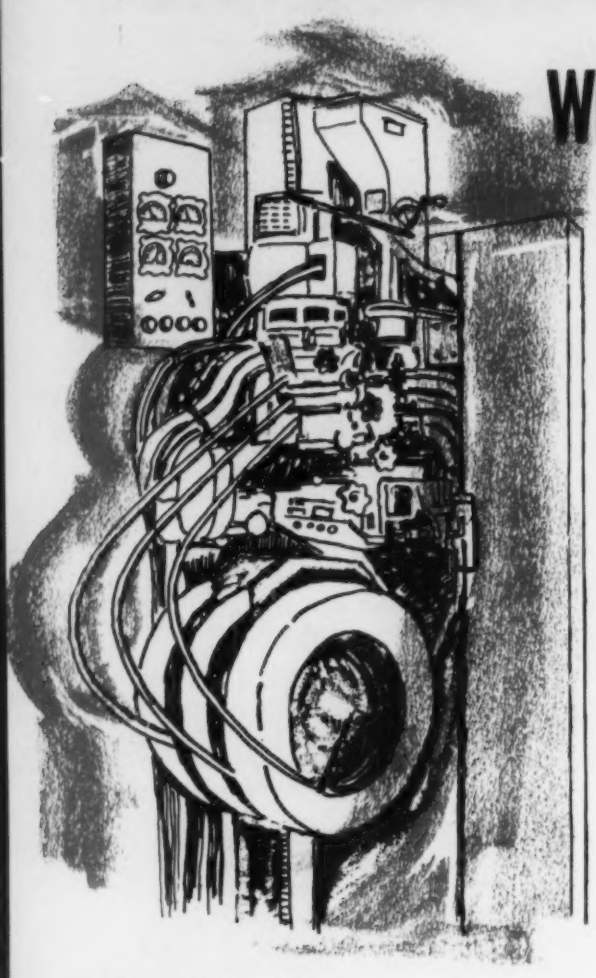
In our progress toward the "better life", are we producing instead a gadgeted life, with everything done for us? If we are, emergency will find us disabled, with our brains, as well as our muscles, atrophied.

Easy doesn't do it, where thinking is involved.



A PRODUCT ENGINEERING SPECIAL REPORT

WHAT DO the RUSSIANS WELD WITH?



"Electro-slag" welders . . .

like this Soviet A-372 with three electrodes, reveal latest Russian design practice in submerged-arm equipment. Machine welds sections from 2⅜ to 9¾ in. thick in one pass at speeds from 16 to 200 in. per hr. As shown here, welding is done vertically with the machine climbing a rack. Electrodes are fed between the plates through projecting guides, at speeds from 8 to 26 ft per min. Gap between the flame-cut edges varies from ¾ to 1⅛ in. For weld over 4 in. thick, electrodes are oscillated in and out along the weld puddle at speeds from 14 to 40 in. per min. About 5 lb of high-Mn flux are consumed per 100 lb of wire.

A British observer reports on design and performance of the latest Soviet production-welding machines. And three US experts put the facts in perspective. Included in this report:

- **Electro-slag welders, highly touted for ultrathick sections**
- **Portable submerged-arc welders for work in confined spaces**
- **Stored-energy spot welders to meet needs for delicate assemblies**

PETER TRIPPE, *London, England*

Welding technology and equipment in the USSR are getting top priority. As a result, the field is developing rapidly—and along original lines in some aspects.

Equipment and techniques now in use in the Soviet Union support this view. The Soviets themselves attribute recent production success to, in part, the continuous development of welding equipment. Particularly, they emphasize that wider use of automatic welding processes—some showing distinctly Russian innovations—have sparked a radical overhaul of manufacturing methods on many structures both large and small. Some reported items:

- The "electro-slag" technique, a new submerged-arc process that welds metal thicknesses up to 10 in. with a single pass, is moving into production manufacture of massive parts like steam-turbine rotors in sizes impossible to make on existing Russian forging presses.
- Improvements on submerged-arc equipment—particularly on mobility, accessibility, and interchangeability from job to job—now permit steel plants to supply storage-tank and pressure-vessel manufacturers with ready-welded shell sections—cutting fabrication time substantially on these items.
- Up to 80% of all welding in prefabricated shipbuilding is being done by automatic submerged-arc welding machines.
- Stored-energy resistance welders for spot, butt and seam welding are being applied to radio and instrument components made from 0.004-in.-thick metal.
- Butt welders in several sizes now permit flash welding of parts like railroad rails and boiler tubes up to 15.5 sq in. and copper wire down to 0.015 in. diameter.

About Mr. Trippe

He contributed to the first US-published report, in *American Machinist*, on Soviet metalworking methods—this followed his 1956 trip to Russia. Formerly an associate editor of the British McGraw-Hill magazine *Metalworking Production*, Mr. Trippe is now a freelance technical journalist. In the present article he combines first-hand observation of Soviet welding equipment with scrutiny of Soviet technical literature and continuing discussions with British experts who have visited the USSR in recent months.

REPRINTED—circle E60, inside back cover

"Electro-slag" for heavy work

This is a submerged-arc welding process using a high-resistance conductive slag that floats molten on top of the weld puddle. Melting results from resistance of the slag bath, combined with high current density in the weld wire. The process comes very close to continuous casting: two sides of the "cavity," into which consummable electrode wire is fed, are the two edges being joined; the other two sides are water-cooled copper shoes that slide upward as the weld metal is deposited. Welding is thus vertical, with the maximum thickness weldable being fixed by the length of weld puddle that can be kept molten. Besides helping melt the weld wire, the hot slag cleans and preheats edges of the joint.

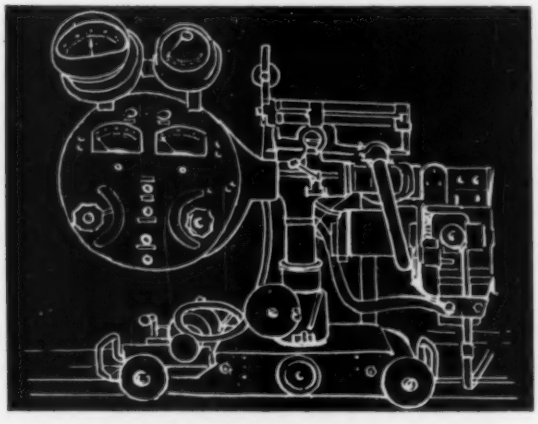
One Soviet slag welder now in use, sketched on facing page, welds metal nearly 10 in. thick in one pass (or "rise"). It uses one to three electrodes. According to Russian engineers, very thick slabs require stirring the slag bath by oscillating the welding electrode(s) along its length. Currents are somewhat lower than for conventional submerged-arc welding. For example, rated current with $\frac{1}{8}$-in. weld wire is about 800 amp (3-phase ac). Current can be remote–controlled in steps from 500 to 1000 amp. Electrode feed control is apparently not tied to arc voltage; changeable gears give coarse adjustment, and motor speed is varied for fine adjustment.

Several advantages are claimed for the process over conventional multipass submerged-arc welding: single-pass feature cuts fabrication time; edge-preparation is simplified to flame-cutting without beveling; consumption of electrode wire, flux and electrical power is reduced substantially, and weld quality is improved.

Submerged-arc welding

This technique is gaining ground in Russia at about the same rate as its popularity is growing in the US.

(Continued, next page, 2nd column)



Trolley-mounted welder . . .

here is the Russian ADS-1000 submerged-arc machine. Automatic feed mechanism handles consumable electrode wire from 5/32 to ¼ in. dia, at rates up to 6 ft per min.—controlled by arc voltage. Max welding current is 1200 amp and arc voltage runs around 35 volts. Electric motor-driven trolley has infinitely variable speed from 4 to 52 in. per min.

THREE US WELDING EXPERTS EVALUATE USSR PROGRESS

1 DAVID SWAN, *Vice-president, Research*
Linde Company Div, Union Carbide Corp

Mr. Swan's commentary is based on his observations during a three-week exchange tour of Russian metallurgical facilities in late 1957. At Zniitmasch (Central Scientific Research Institute for Technology and Machine Construction) in Moscow, one of the institutes of the Soviet Academy of Sciences, he examined some of the equipment described in Mr. Tripp's report. It is institutes like this that do the orginal R & D work on most Soviet machines and production processes.

The "electro-slag" process is a significant and truly original Russian contribution to welding technology, representing an area where the Soviets are taking a decidedly different approach to heavy section welding. On the other hand, the submerged-arc equipment on which they depend so much is copied directly from US machines of 5 to 10 years ago.

This seeming contradiction in thinking on apparatus development is actually an illusion: If Western equipment will do a job that is vital, copy it; if it's impossible to copy, figure out an alternative. The latter approach resulted in "electro-slag" welding: Lacking our heavy press and rolling facilities, the Soviets had to devise a method of constructing ultra-large parts like turbine rotors and press frames. The significance of this process has not been lost on Western designers of heavy machinery. For example, as turbine rotor designs move into the 200,000-kw range, even our own forging press capacity, large as it is, becomes strained. Perhaps "slag" welding will prove an attractive alternative to further capital investment in heavier presses.

Mr. Trippe cites 10 in. as a top thickness for the A-372 slag-welding machine; however, sections up to 18 in. welded by "slag" technique were displayed by Soviet engineers at Zniitmasch. As for applications, it was stated that rotors for 150,000-kw turbines had been fabricated this way, and we saw frame members for heavy presses that were constructed by "slag" welding four steel slabs about 96 in. x 6 in. x 4 in. into one monolithic slab. Oscillation of electrodes above 4 in. thickness, mentioned by Mr. Trippe, is believed to control the dendritic growth pattern in the weld, giving multipass weld quailty.

As this equipment shows, Soviet designers are not novices. One other associated piece of equipment struck me as highly original. This was a self-propelled "turtle" for walking the "slag" welding head up a vertical curved surface like a ship hull. This device, small enough to be portable, is equipped with electromagnetic feet that are alternately moved forward, energized while the carriage moves up, and de-energized for the next step.

RUSSIAN WELDING (cont.)

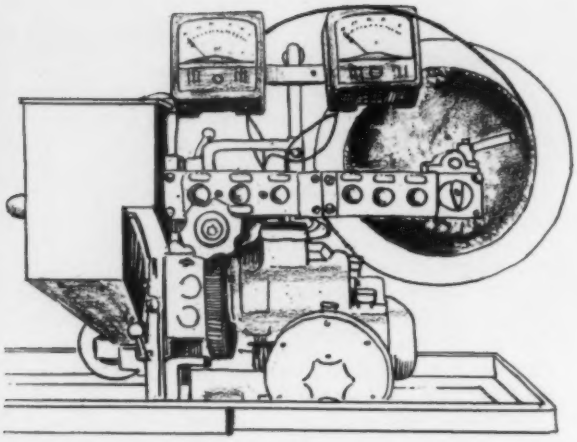
2 DIMITRI VVEDENSKY, *Welding Consultant*
Columbus, Ohio

Mr. Vvedensky's interest in welding goes back to the 1930's and his career as a welding engineer at Skoda in Czechoslovakia. A teen-age student in Russia in 1918, he fought as an officer in the White Russian army, made his way via Turkey to Czechoslovakia—where he completed his engineering education. Coming to the US after the Reds took over Czechoslovakia in 1948, Mr. Vvedensky followed his profession in American industry—along with a two-year period teaching welding technology at Brooklyn Polytechnic Institute. Currently a consultant, he continues to follow Eastern European technical literature.

It is true that the Russians have progressed much in welding since World War II. But note that this progress has not been uniform throughout the field. In welding, as in nearly every major Soviet industry, there are two areas of effort, and they reflect different rates of progress. One concerns the top-priority industries like aircraft and heavy machinery; the other is the area of general industry. Welding-equipment development for top-priority industries progresses rapidly, and every lead offered by the rich technical literature of the West is followed avidly—often with strikingly original approach. The so-called "electroslag" process, an offshoot of submerged-arc welding, is an excellent example. And the Soviet aircraft industry, from all indications, has all the basic Western welding equipment known—supplied by its own research institutes which study new developments and build the equipment needed.

Progress in welding for general industry, on the other hand, is much slower. The workhorse process is submerged-arc welding, based on Western technology. This process is not only used for low-carbon and low-alloy steels, but with modified fluxes for stainless and heat-resistant steels and alloys. It is used, too, for aluminum and occasionally titanium, materials which we weld with inert-gas-shielded arc methods. But there isn't enough inert-gas production in Russia for this approach, and inert-gas equipment is still scarce. An exception appears to be automatic units for circumferential pipe joints in fixed position, for which the Soviets use argon shielding for stainless and CO_2 for low carbon steel.

Manual arc welding is not as advanced as it should be—principally because welding electrodes in the USSR are made by the consuming plant and often there isn't enough wire and coating materials to go around. Roughly the same situation exists in resistance welding: research institutes develop modern machine or copy the West's, but there are not enough of them for all industries. The general impression, then, is of a current scarcity of materials, equipment, and manpower. This is partly due to the cumbersome nature of the planned economy, partly that there is so much to do and so little time.



This fully automatic welder . . .

is a lightweight portable designed for circular joints inside tanks or piping over 48 in. dia. The TS-17-M machine has a swivelled head to permit corner welds encountered in welding internal reinforcing rings in tanks. Designed for trolley mounting, the TS-17-M rides inside the tank on interchangeable rollers at speeds from 10 to 80 in. per min. Welding current is variable from 200 to 1000 amp, and the welding head will feed either coiled wire or straight rod in diameters from 0.06 to 0.20 in. dia. With the 0.06-in. wire, corner joints can be welded in light-gage metal down to 0.079 in. thickness.

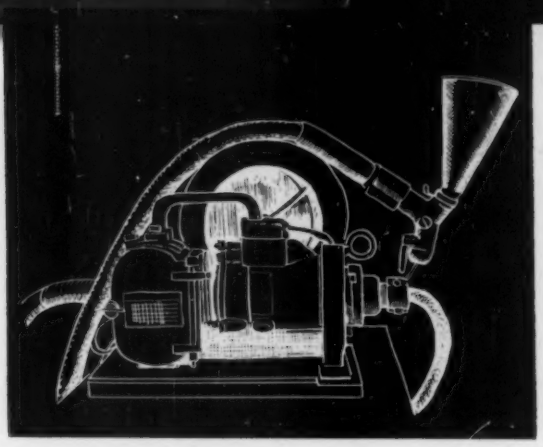
Soviet engineers have concentrated on perfecting available Western designs of fully-automatic and semiautomatic machines. Russian automatic types are emphasizing mobility and self-contained power sources. Welding head, generator, controls and wire-feed mechanism are all mounted on portable, motor-driven carriages that ride directly on the workpiece or on portable sections of track. Travel speeds vary from 4 to 80 in. per min. and weld currents run up to 1200 amp (low by US and UK standards).

Submerged-arc welding in confined spaces seems as knotty a problem for Soviet engineers as it is for Western welding men. In addition to the fully automatic TS-17-M mobile units, semiautomatic machines for the hard-to-reach welds have been developed. These machines feature welding heads separate from the feeder and power units to get greater accessibility, and use small weld wire for rapid feed—along with fairly high current density for arc stability. Thus, high welding speed can be maintained continuously. One of the latest semiautomatic units reportedly controls wire-feed rate from arc voltage.

Resistance Welding

Soviet engineers are reportedly making strides in stored-energy resistance welding, a technique not nearly as developed in the USSR as in the West. Capacitor welders are now being used for low-carbon steel, brass and light alloys. Principal area of Soviet development appears to be electronic controls to measure and time the energy discharge from the capacitor bank. With accurate control from 3 to 62 watts per sec, sheet metal in thicknesses from 0.004-.011 in. is being spot-welded.

Design of capacitor-discharge equipment is conventional: 3-phase power supply is rectified to high-voltage



Semiautomatic welder . . .

of submerged-arc type is this Russian PSh-5-y, reportedly used for any joint where fully automatic welding is impossible or unwarranted. Hand gun, shown draped over wire-feed mechanism, has conventional funnel receptacle for flux and is supposed to weigh slightly over 14 lb, including feed cable. Welding current is adjustable between 80 and 650 amp (not high by US and UK standards) and the hand gun will take either coiled wire or straight rod in diameters up to 0.079 in. Wire feed is controlled by change gears, giving a range of constant feeds from 4.3 to 32.8 ft per min.

dc current, which then charges a bank of capacitors. Suitable controls cause the bank to discharge a current impulse through the welding transformer to the electrodes. Wave form can be altered by changing transformer winding ratio, capacitance, or condenser voltage.

On the latest Russian production model, current discharge time is estimated to be about 1 millisecond. The upper electrode can be moved either by foot pedal or electromagnetically. Welding pressure is applied by springs, rather than pneumatically. An electronic timer permits variation of welding cycle between 0.7 and 3 sec (from 20 to 90 spot welds per min.). Maximum charging current is 4 amp, and capacitor voltage is 500 volts at a capacitance of 25 to 500 mfd.

A variety of automatic butt welders are now on the Russian market. Typical is the new MSM-150-3 machine designed for continuous flash-butt welding of low-carbon steel parts. Rated at 150 kw, this welder has a max production rate of 120 welds per hr, with max upsetting force of 14,300 psi. Clamping system is driven electromechanically, with interchangeable clamping jaws that accommodate up to 1.2 sq in. on automatic operation—up to 3.9 sq in. semiautomatically. Work in the latter category is preheated in the clamps before the automatic control system takes over.

A second automatic butt welder, reportedly developed at the Soviet Academy of Science, is the ASM-1. This carriage-mounted machine is used extensively to butt-weld copper wire from 0.015 to 0.051 in. dia. Upsetting force is by precalibrated spring, with a microswitch for current shut-off at appropriate point in the stroke. Design includes a shear for cutting the wire and a device to anneal the joint after welding. Production rate is 180 welds per hr on a continuous basis.

Typical of Russian bench-type spot welders is the MT-50-M, a pedal-operated machine adaptable to automatic production. Nominally rated at 50 kw, its production rate is 3000 welds per hr at 4400-psi electrode force on 0.079-in.-thick metal.

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3 **ROBERT J GASSER,** *Applications Engineer*
Sciaky Bros Inc, Chicago

Mr. Gasser first became intrigued with resistance welding in the late 1940's, as an electrical engineering student at Illinois Institute of Technology. A Sciaky test service engineer until 1954, he learned the ins and outs of all kinds of resistance welders—and became a specialist in flash-butt welding, which remains his current major interest as an applications engineer.

It is apparent from Mr. Trippe's report that Soviet advances in resistance welding have not been as rapid as in arc-welding techniques. In general, the Russian equipment described here does not have the capacity, speed or flexibility of current Western machines. This is quite understandable: the West has been at it much longer. A few comparisons will put these views in focus.

Take butt welders for example. The Russians are apparently following the Western practice of designing specific machines for specific jobs, since the shape of the part is important. Maximum permissible cross-sectional area, however, appears to be much lower: about 16 sq in. vs 100 sq in. on existing US equipment. Maximum forging force is lower too: 14,000 psi vs 50,000 psi. The higher figure for US flash-butt welders comes from our emphasis on joining heat-resistant aircraft metals like the newer cobalt-base alloys. On weld speeds, fully automatic Western equipment can handle production rates of 600 welds per hr (auto rims) as against 180 for the Russian ASM-1. This reflects our earlier interest in mass-production methods.

On spot welders, the Russians appear to be relying more heavily on stored-energy equipment—presumably because of present power supply difficulties. In the West, this type equipment is well developed—though usually reserved for specialty jobs. For welding steel and heat-resistant metals, however, a current of longer duration and lower magnitude is usually needed. On seam welding, for example, a continuous flow of current is needed.

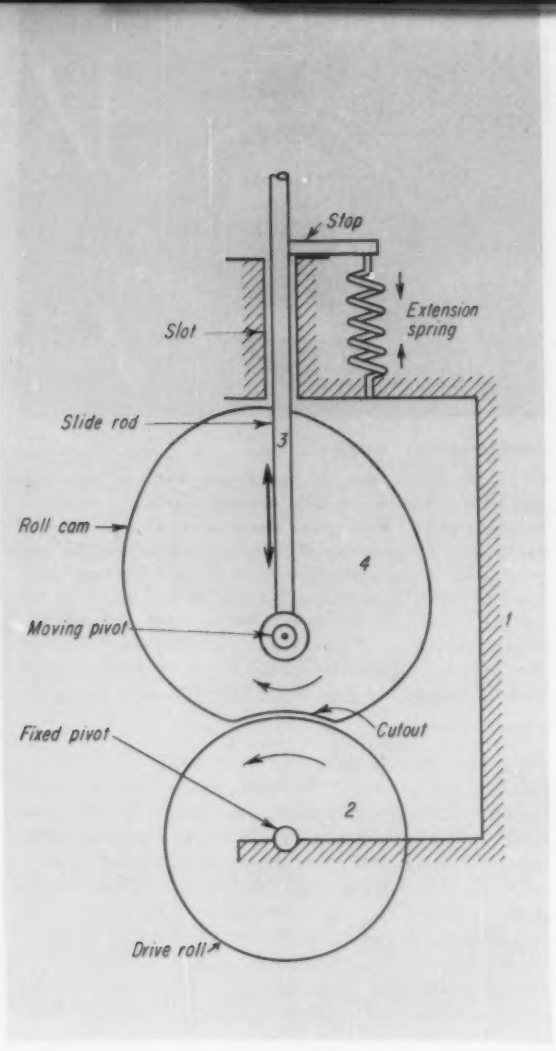
Latest Western spot and seam welders work directly from 3-phase power supply and have controls that can vary current so flexibly that aluminum, mild steels, heat-resistant alloys and magnesium can be welded. These controls actually count cycles of alternating-current line frequency and do not vary with changes in circuit components because of aging, temperature and so on. Preheat and post-heat currents are used here as integral part of the control, initiated automatically to get best metallurgical quality in the weld nugget. The Russians are apparently working on heating controls too—a necessity adjunct to resistance welding for pressure-tight welds in applications like fuel tanks, pressure vessels and some jet engine components.

ROLL CAMS:

they stop and go on demand

Here is a graphical method for designing simple, cam-like mechanisms that give a prescribed motion when triggered. Two examples from industry—a record changer and an electric typewriter—are worked out in detail.

A C DUNK
Assistant Professor
Mechanical Engineering, Purdue University



1 Record changer . . .
has this roll-cam mechanism. Path of movable pivot is rectilinear. Cam is triggered by rotating cam slightly until it contacts drive.

Roll cams are intermittent mechanisms that can be triggered by slight finger pressure to produce a prescribed linear or rotary motion. Although found in some electric-typewriter and record-changer mechanisms, they are still comparatively unknown. In fact, design literature is rather devoid of any mention of these cams.

Yet they are simple to build and of rugged construction—their rolling contact causes almost no wear, and once their contour is properly designed, they can be counted on to give good performance over a long period.

The graphical method presented here for designing their contour is new and easy to apply. Two examples of its use in machines are shown—one for obtaining rectilinear motion and the second for curvilinear motion.

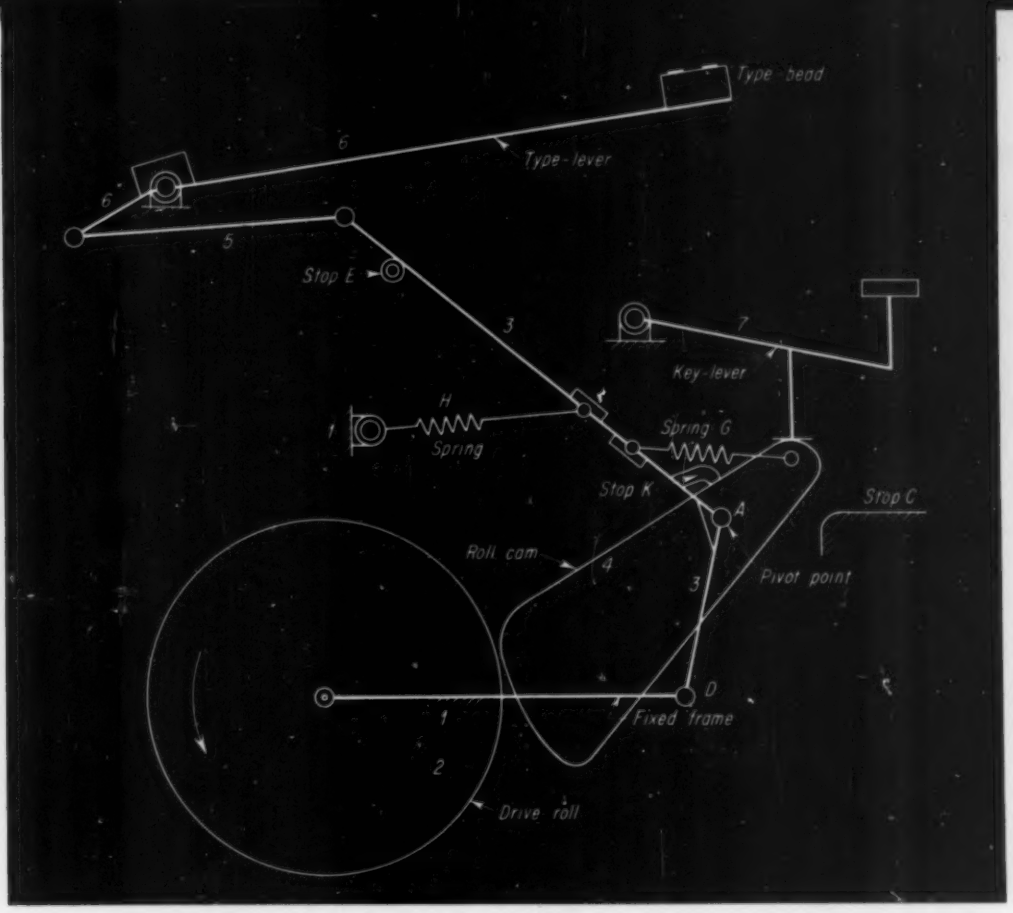
How a Roll Cam Works

The roll-cam mechanism shown in Fig. 1 is for a rectilinear type—its job in an RCA 45-rpm record changer is to control tone-arm motion and record changing. Basic components are:

- **Drive roll**—rotates at constant speed about fixed pivot and provides input power.
- **Roll cam**—its cutout allows it to dwell until activated.
- **Slide rod**—is reciprocated by rotation of the roll cam.
- **Frame**—provides a fixed pivot and slot for the rod.

The sketch shows the mechanism in the dwell position—cam and drive not in contact. To start the cycle, finger pressure is employed momentarily (through a lever not shown) to slightly rotate the cam until it comes into contact with the drive roll (which an electric motor is rotating at constant speed). Friction between the surface then rotates the cam, in turn causing the rod to move upward. The cam goes through a complete cycle and returns down to its original position. Here the stop on the frame will arrest the cam, which will again be out of engagement until activated again.

Spring pressure prevents slippage during rotation—especially during the return cycle. However, to make the transfer of motion more positive, one member can be made of rubber and the other of metal with small serra-



2 Electric-typewriter mechanism . . .
uses roll cam for motion amplification. Here, path of pivot point on roll cam is curvilinear.

tions on its periphery. To prevent any slip whatsoever, conjugate tooth forms could be used.

Finger-touch Operation

Roll cams are also employed in IBM electric typewriters, Fig. 2. Here the cam is triggered by a touch of the typist's finger to power the type heads.

The roll is driven by an electric motor at constant speed. Cycle begins when the typist depresses the key lever which rotates the cam into contact with the drive roll. The cam is connected to link 3 at pin point A. Rotation of drive roll makes link 3 rotate clockwise, causing link 6 to rotate (via link 5) until the type head contacts the platen (not shown).

At end of the cycle, the cam strikes stop *C* and loses contact with drive roll. Spring *G* then returns the cam to its position against the stop *K*.

During this time, while cam and drive are disengaged, the type head continues to approach the platen because of kinetic energy stored in type lever (link 6). After type head strikes platen, spring *H* returns the linkage to the home position where link 3 contacts stop *E*.

Design Procedure Is Special

Roll cams thus appear similar to disk cams with reciprocating roller followers, especially when of the record-changer type. So it would seem possible to lay out the cam by one of the methods that utilize the process of inversion to obtain the cam profile as the envelope of the roller profile. However, this method is not applicable.

The rolling curves are centrodes (loci of instant centers), hence the problem is one in which one centrode (contour of the drive roll) is known and the other (contour of roll cam) must be determined. The author's method is based on the fact that the point of rolling contact is an instant center and hence lies on the centrode. Considerable use is made also of the concept of inversion by which the follower is assumed to revolve around the cam, instead of vice versa. Two examples illustrate the method of laying out the roll cam profile.

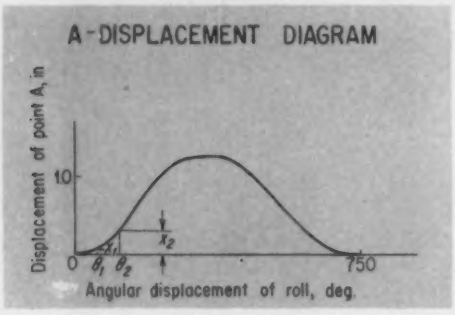
EXAMPLE I—RECORD-CHANGER ROLL CAM

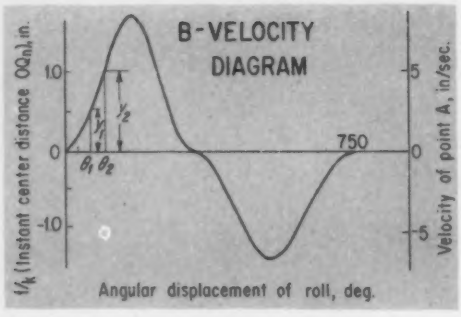
Data that must be known are drive-roll diameter and desired position of slide rod with respect to angular displacement of the drive roll (once the cam is activated). The rod position is usually specified by a displacement diagram, Fig. 3(A). The velocity characteristics of the rod must also be known, Fig. 3(B), but this can be determined directly from the displacement diagram by graphical differentiation (for a fast new method see *PE* —Oct 13 '58, p 77).

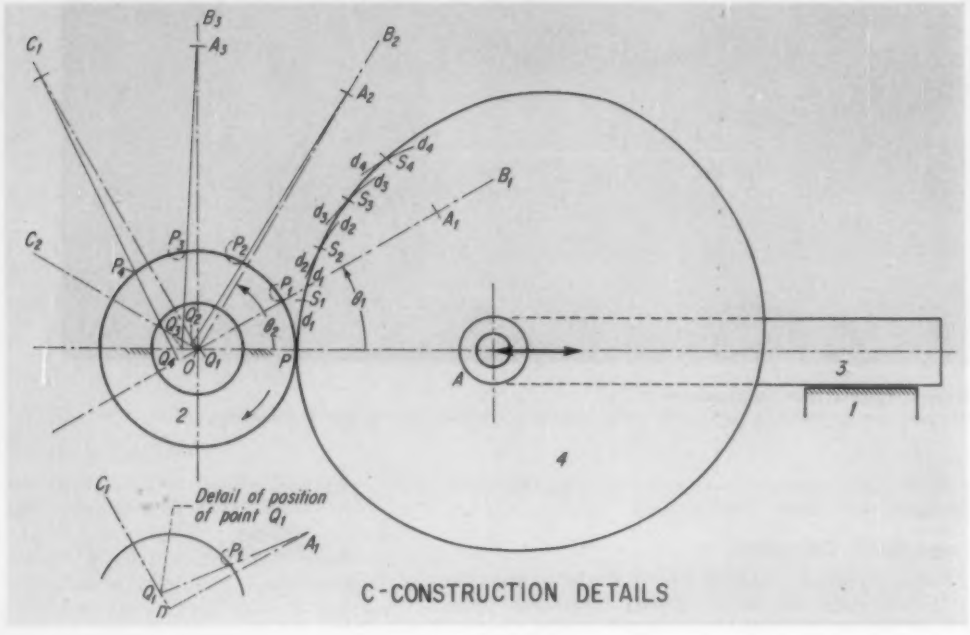
Construction—First Inversion

Construction details are shown in Fig. 3(C). Draw the drive-roll circle with given diameter, the line of travel of the point *A* through the drive roll center *O*, and locate *A* at an assumed initial center distance *OA*. The drive roll is to rotate clockwise; therefore in this inversion,

3—LAYOUT OF ROLL CAM FOR RECORD CHANGER







link 3 (the slide rod) will rotate counterclockwise with respect to link 2. Draw OB_1 at angle θ_1 (say, every 24°) measured counterclockwise from line OA. Locate A_1 so that OA_1 is equal to $OA + x_1$ (x is measured from the displacement diagram). Draw OC_1 perpendicular to OB_1 and locate the instant center 23 (for links 2 and 3) at Q_1 on C_1O so that OQ_1 is equal to ky_1 (y is measured from the velocity diagram where $ky_1 = OQ_1$ = velocity of A_1 divided by the angular velocity of link 2). Join A_1 and Q_1, and locate P_1, the point of contact and instant center 24 for this position, at the intersection of line A_1Q_1 and the drive-roll circle.

Second Inversion

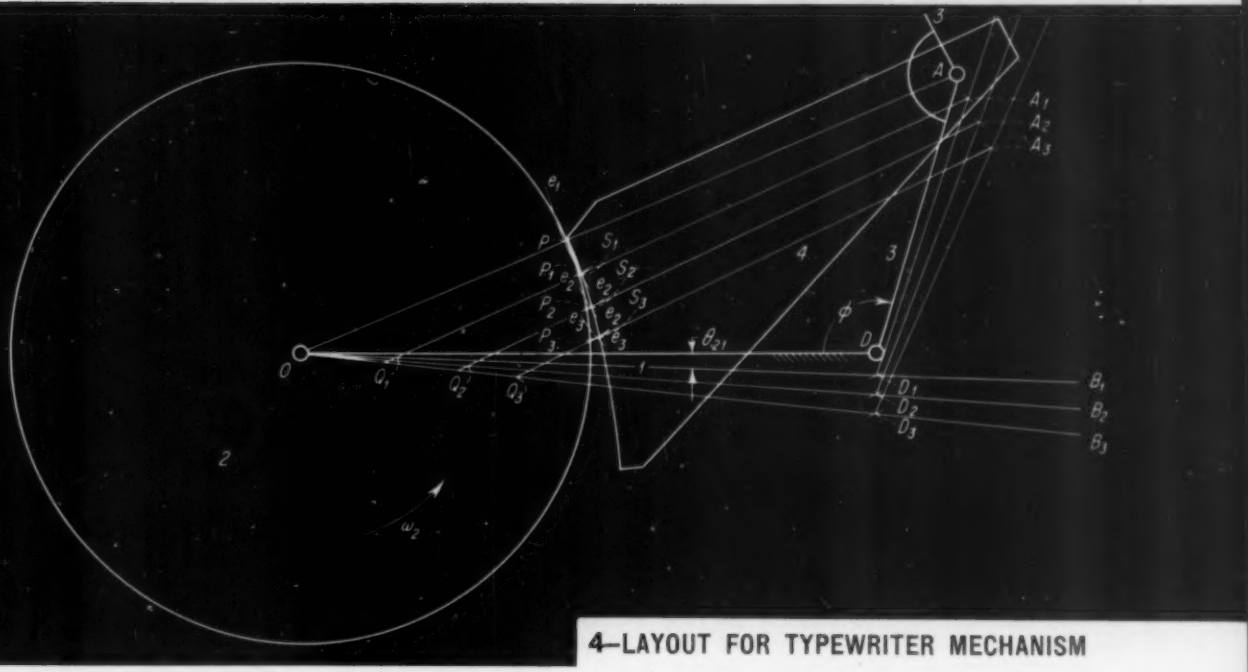
Arc PP_1 on the drive roll must equal the mating arc PS_1 on the roll cam. This fact is now used to locate S_1, the first sought-for point on the roll cam. Imagine inverting the linkage again by holding the cam stationary and allowing the other links to move. With center at A and a radius equal to A_1P_1, describe the arc d_1d_1. Locate S_1 on this arc so that arc length PS_1 is equal to arc length PP_1. If the distance PP_1 is kept small, sufficient accuracy can be obtained by making chord PS_1 equal to the chord PP_1.

The points A_2, Q_2 and P_2 are located in a similar manner. Point S_2 is then located by making the arc S_1S_2 equal to the arc P_1P_2. The required roll cam profile is obtained by drawing a smooth curve that goes through P and the S_n points.

EXAMPLE II—TYPEWRITER ROLL CAM

In the roll-cam profile for a typewriter mechanism, Fig. 4, link 3 is to rotate clockwise with constant angular acceleration to minimize dynamic effects. The drive roll, link 2, is to rotate 14° counterclockwise at constant speed ω. The dimensions of links 1, 2 and 3 must also be given.

Employing notations such as α_{21} to denote the angular acceleration of link 3 with respect to link 1, these equations can be set up:



4—LAYOUT FOR TYPEWRITER MECHANISM

$$\phi_{21} = \alpha_{21}\,\theta^2_{21} / 2\omega^2_{21} \quad (1)$$

and

$$\omega_{21}^2/2\,\alpha_{21}\,\phi_{21} \quad (2)$$

however

$$\omega_{21} = \alpha_{21}\,\theta_{21}/\omega_{21} \quad (3)$$

and therefore

$$\omega_{21}/\omega_{21} = 2\,\phi_{21}/\theta_{21} \quad (4)$$

Assuming a value of $\alpha_{21}/2\omega^2_{21} = 1/20$, the values of θ_{21}, ϕ_{21}, ω_{21}/ω_{21} have been calculated from Eq (1) to (4) and are provided in the following table.

θ_{21} (deg)	ϕ_{21} (deg)	$\frac{\omega_{21}}{\omega_{21}}$	OQ_n (in.)	DQ_n (in.)
2	0.20	0.2	1.00	5.00
4	0.80	0.4	1.72	4.28
6	1.80	0.6	2.26	3.74
8	3.20	0.8	2.66	3.34
10	5.00	1.0	3.00	3.00
12	7.20	1.2	3.28	2.72
14	9.80	1.4	3.50	2.50

The instant center Q between links 2 and 3 must lie on the line of centers OD and be located so that

$$\omega_{21}/\omega_{21} = OQ/DQ \quad (5)$$

and

$$OQ + DQ = \text{center distance} \quad (6)$$

Assuming values for the roll radius = 3 in. and $OD = OQ_n + DQ_n = 6$ in., the values for OQ and DQ in the above table were calculated from Eq (5) and (6).

Location of the points of contact between links 2 and 4 are first found on link 2 by inverting the mechanism 1-2-3-4 and making link 2 the fixed link. This determines the spacing of the points of contact P_n (instant centers 24 on link 2) on link 2 corresponding to the values of θ_{21} tabulated. The arc lengths $P_{n-1}P_n$ (on link 2) thus found will be equal to the corresponding arc lengths on link 4.

The mechanism is again inverted, making link 4 the stationary link, to determine the centrode PS_n which is the locus of the instant center 24 on link 4.

Construction—First Inversion

Draw OB_1 at angle of $\theta_{21} = 2°$ measured clockwise, and locate D_1, making $OD_1 = OD$.

Locate Q_1 on OD_1, making OQ_1 equal to computed value in the table (1.00).

Draw D_1A_1, making an angle equal to the assumed initial angle ϕ_0 plus the displacement ϕ_{21} (0.20°) with the line OD_1.

Join A_1 and Q_1 and locate P_1 at the intersection of this line and the roll circle.

Second Inversion

In this inversion, link 4 is held stationary with respect to the paper. With A as the center and with a radius equal to A_1P_1, describe a circle arc e_1e_1. Locate S_1 on this arc so that the arc length PS_1 is equal to the arc length PP_1.

The other S_n points are obtained in a similar way. The required profile then is obtained by drawing a smooth curve through P and the S_n points.

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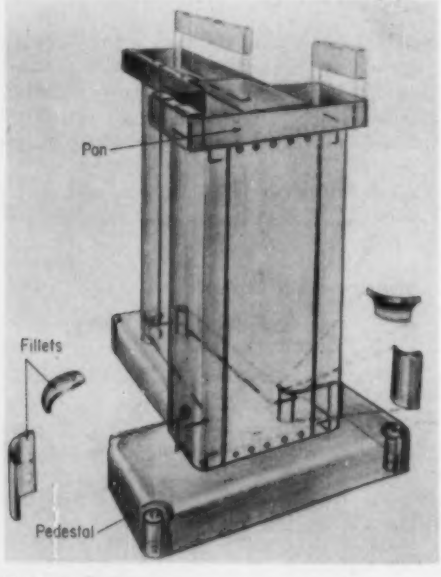
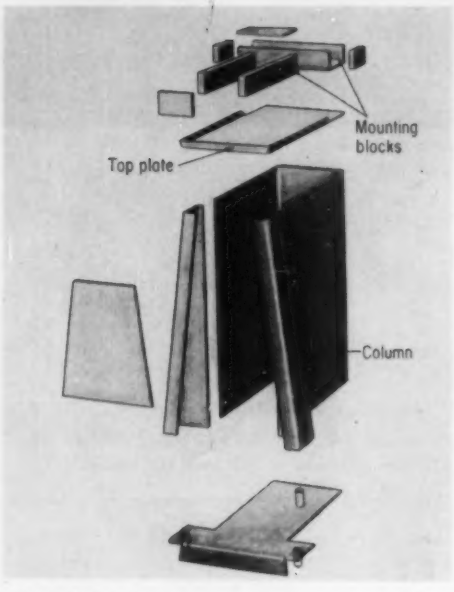
when QUICK REDESIGN paid off

There was no hesitation in trying something better when production problems showed up with the initial design. It's now the same grinder but with a base that looks better, assembles easier, and cuts production cost by 38%.

Comparison of new and former base shows better appearance and simpler assembly when pedestal was eliminated. New base is easier to clean; also, bolt-down holes are now inside and easily reached through rear access panel. No. 5 Cutter and Tool Grinder is produced by Brown and Sharpe Mfg Co, Providence, RI.



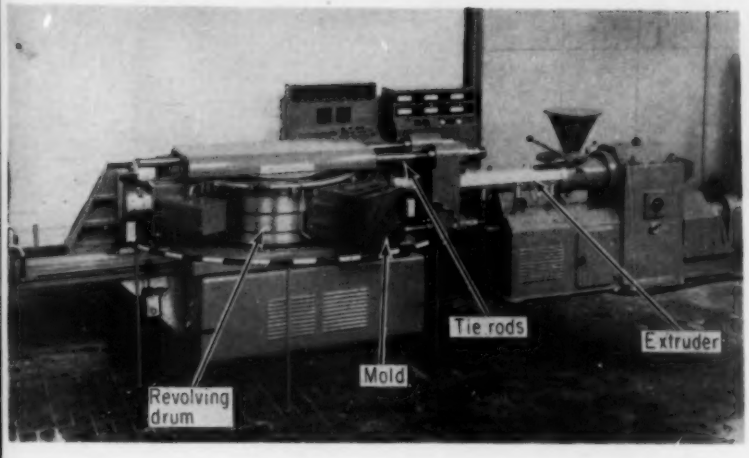
Former base . . .
was sturdy and inexpensive but this design introduced assembly and welding problems when production began. Bent edges of the pedestal required convex and concave fillets for corners—this meant additional welding and grinding. And pedestal shape—a narrow "T"—required welding in confined space. Angles welded to pedestal and pan were superfluous except as a means of locating front panel in final welding operation. Separate wrench rack had to be fabricated and attached to base. After grinding and polishing welds, base had to be machined as a unit by milling top and bottom pads, drilling and tapping.



New base . . .
brought several improvements: simplified components; reduced the length of weld needed for assembly; incorporated many machined subassemblies; improved appearance.

Individual components were designed for shearing to size and shaping on standard tools. Nibbling and sawing operations were eliminated. Doing away with the pedestal eliminated its numerous fillets. Fewer inches of welding are needed and, with wider column, most of this is concealed, reducing grinding operations to a minimum. Mounting blocks are predrilled prior to welding, eliminating machining after assembly. Critical dimensions between hole centers used for mounting grinder are held to 0.005 in. after welding. Final fitting of dowel holes for attaching grinder is achieved by hand reamer. Further savings came by incorporating the wrench rack to the top plate, and reducing thickness of steel from #7 to #10 gage.

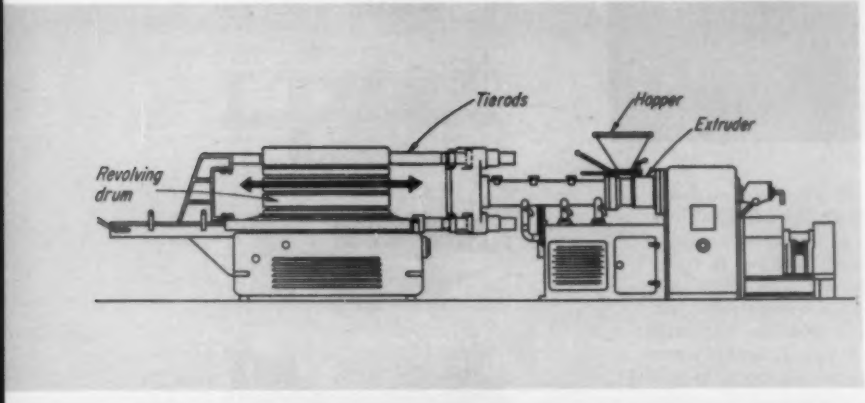
IN NEW PRODUCTS

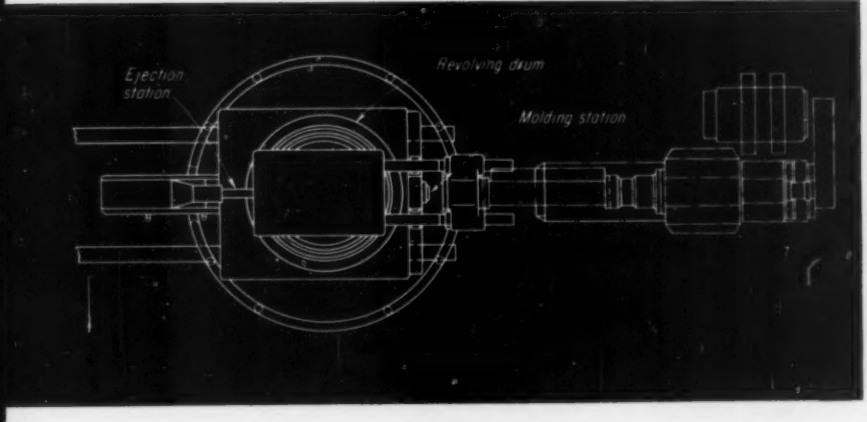


With different molds riding a revolving drum, this machine gives mass production—or components of widely varying shapes and sizes. And its extruder helps by homogenizing the material.

The drum can accommodate up to 24 separate molds with capacity ranging from 3 oz to 6½ lb. Maximum rated output of extruder is 555 lb per hour. "Extr-a-formatic" is produced by Paul Troester Maschinenfabrik, Hannover-Wuelfel, W. Germany.

Speedier Molding by MERRY-GO-ROUND





Four bolts . . .
provide the coupling between extruder and molding machine. Remove four nuts—and the molding machine can be withdrawn for cleaning or changing the extruder screw. This also gives a quick way to remove the extruder unit for other work.

Four tierods connect front plate of the molder to the stationary center of the revolving drum. Injection and molding is done by sliding the revolving drum along centerline of the extruder. The sliding action is provided by a hydraulically operated toggle linkage.

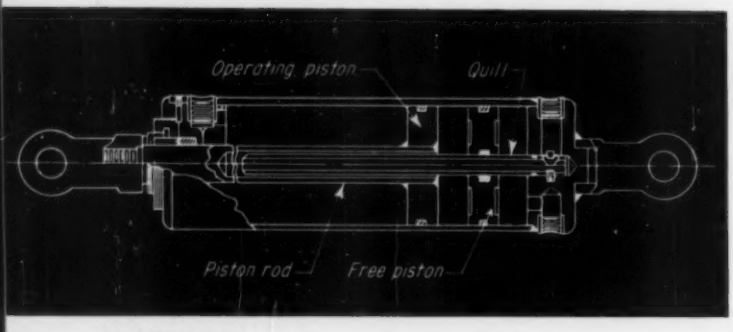
When directly opposite the molding station, the mold opens and ejects the workpiece. The same motion that moves the mold up to the nozzle of the extruder effects the initial opening of the opposite mold. Pneumatic or mechanical strippers provide final removal of the molding.

The extruder is able to plasticize material at a steady rate because it doesn't have to wait for long mold-cooling cycles. This gives high-volume production. Also, thorough homogenizing given by the extruder permits lower closing pressures, uniform stress-free moldings, and reduced flash. In addition, preplasticizing with the extruder results in quicker, more uniform heatup because mechanical energy of the extruder screw is converted to heat.

It's done by adding a free piston to the hydraulic cylinder that operates the tractor's agricultural implements. This second piston serves as adjustable stop for the operating piston.

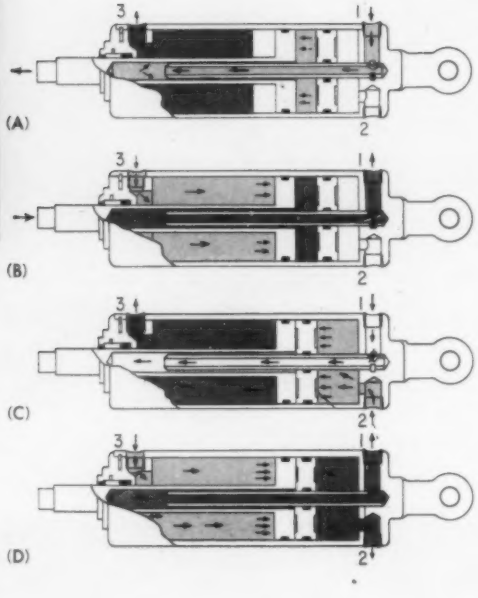
The hydraulic cylinder is set for desired implement depth; holds that setting while the implement is raised and lowered. Result is complete control from the tractor seat—the driver doesn't have to stop the machine and readjust working depth of tools to meet varying conditions. Hydro-Stop Cylinder is produced by Densmore Engineering Co Inc, Compton, Calif, for Oliver Corp, Chicago.

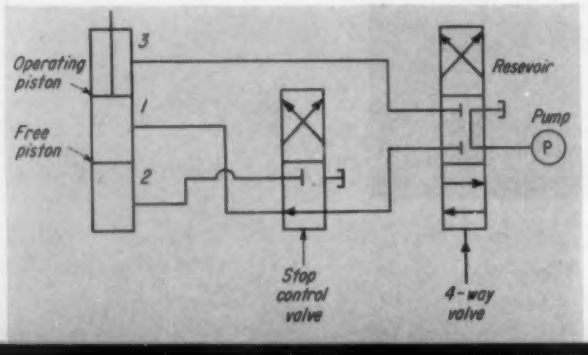
Tractor Tools Adjusted on the Move



Double-piston . . .
hydraulic cylinder uses its free piston as adjustable stop—it limits travel of operating piston to length of stroke desired. Quill and piston rod, both hollow, allow oil pressure to be exerted on either side of free piston to set stroke adjustment (sketches at right):

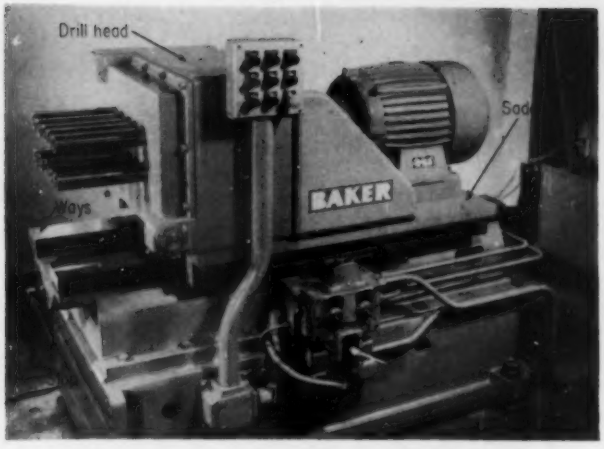
To extend piston rod in (A), working pressure is applied to port 1, travels through quill and piston rod, and moves piston to left. Port 2 remains locked, holding free piston in position. To retract piston rod (B), working pressure is applied to port 3, moving piston to right. Oil between operating and free pistons is returned to tank through piston rod and quill. Port 2 remains locked and free piston limits operating stroke. To decrease working stroke (C), working pressure is applied to port 2, forcing free piston and working piston to left. Oil returns to tank through port 3, and suction at port 1 draws oil in to fill increased volume in extended piston rod. To increase working depth (D), working pressure is applied to port 3 to force operating and free piston to right. Ports 1 and 2 are open to return oil to supply tank.





Circuit diagram . . .
shows dual-valve setup that sets free-piston stop at desired position. Four-way valve operates cylinder during normal cycling.

Cylinder and control valve can be used with any 3- or 4-way hydraulic system. System shown uses stop control valve to position the free piston stop and 4-way valve to control the operating piston.

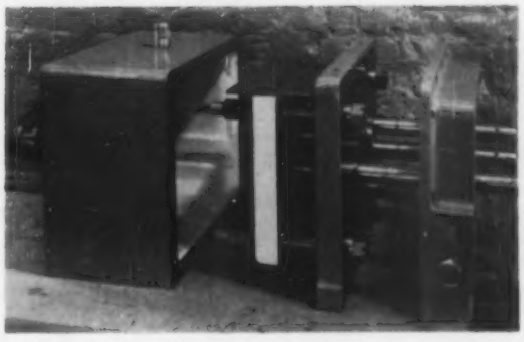


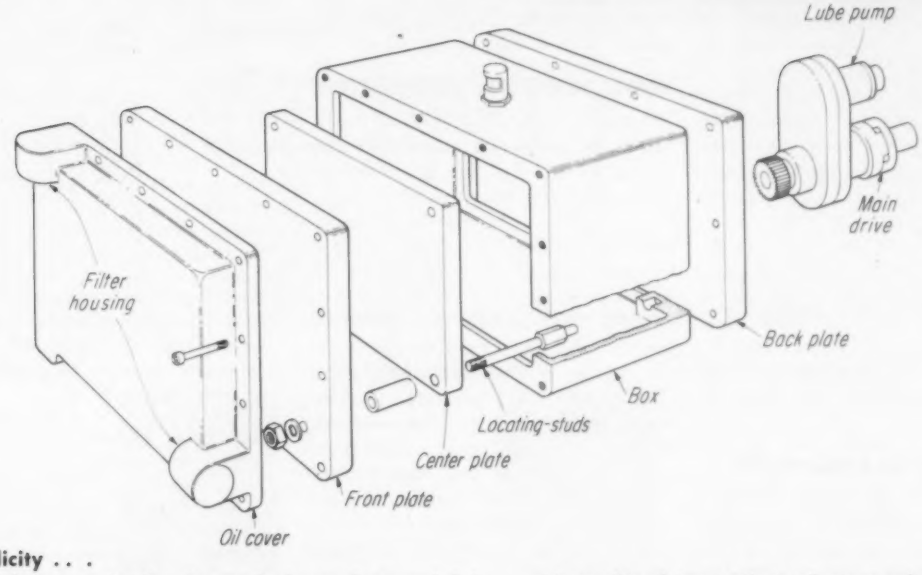
10-spindle unit . . .
shows appearance of complete machine. Drillhead is mounted on building-block base with welded steel end-bed. Nut on bolt projecting from front of bed is positive stop that acts directly on the hydraulic cylinder rod-end operating the saddle. Hardened steel ways are set over keys in base casting to assume proper alignment. Spring-loaded steel wipers mounted on saddle prevent chips and dirt from getting between saddle and ways. Independent system guarantees lubrication of drillhead at all times. Automatic lubricator supplies oil to grooves cut in underside of saddle. Hydraulic controls and piping are externally mounted for accessibility during maintenance and adjustment.

Custom Drillheads from Stock Parts

Here's a method that speeds production of drilling machines. The heads start out as basic components kept in stock. They are machined to meet any desired spindle pattern; and in assembling, castings go together like a watch case.

Horizontal drilling machine is used primarily for attachment to transfer machines or special fixtures in large production runs. Unit may be inclined up to 7° without change; over 7°, counterweight is added to balance drillhead. The machine is produced by Baker Brothers, Toledo, Ohio.





Simplicity . . .
of watch-case construction is seen in lower photo—exploded view of a complete 3-spindle drillhead ready for assembly and installation. Sight glass on oil cover indicates oil level; bubbler atop box section gives instantaneous visual check of lube pump operation.

Drawing shows basic drillhead components as stocked. Entire unit consists of two castings, oil cover and box, plus front, center and back plates. Main drive gear and independent drillhead lube pump are mounted on rear plate. Final construction consists of drilling the oil cover and front and center plate for desired spindle pattern; and installing drive gears between front and center plates.

A PRODUCT ENGINEERING

SPECIAL REPORT

WHICH Fhp motor FOR THE JOB?

Pinning down the right electric motor becomes simpler with this twin-pronged method. First, know the basics of how the different candidates work. Then let application and cost guide you to the best answer in charts supplied by the author.

N L MORGAN

Applications Engineer, Specialty Motor Dept, General Electric Co

Basic charts will simplify the answers to that everyday problem—what's the best small motor for the job? But the charts should be scanned with an understanding of what gives the motor its starting and running characteristics. Otherwise, the charts cannot be precise enough, and will lead to ambiguity. For example, it is seldom possible to point to a given application and decide right there on the motor type.

Selection should be a step-by-step procedure. First must come the choice between commutated and induction motor, depending on power supply and the performance needed. Next, the required running characteristics (rotor type for induction motors, winding type for commutated motors). And third, the starting characteristics needed.

With this done, the charts can become fast and useful tools: the application can be given its full importance; so can cost of the motor, and also its mechanical makeup—for example, its weatherproofing and method of mounting (*PE*—Dec 22 '58, p 60).

INDUCTION VS COMMUTATED

The basic difference between induction and commutated motors is in how the rotor is energized (see box opposite). Compared with induction types, the commutated motors are:

- Suited for adjustable-speed applications, because speed may be accurately varied over a range as great as 200% of rated speed to zero speed by controlling the voltage. Significantly enough, they are widely used on specially rectified ac power to take advantage of this characteristic.
- Limited, with the exception of universal-series motors, to dc operation. Induction motors are confined to ac use.
- Inherently self-starting. Most induction motors require a starting winding.
- More costly to manufacture, all other things equal, than comparable ac motors because they require wound rotors, brushes and commutators.

INDUCTION MOTORS—3 MOTOR TYPES

Generally, the field winding determines the power output and speed of an ac motor, and the rotor design determines the shape of the speed-torque curve. The induction motor essentially converts cyclical reversals of current from electrical energy to mechanical power. Hence, motor speed is dependent on the power frequency supplied to it and on the number of poles in its stator winding.

A 2-pole stator winding, for example, will give a synchronous speed of 3600 rpm at 60 cycles, 3000 rpm at 50 cycles; while a 4-pole winding reduces speed to 1800 rpm, and 6-pole to 1200 rpm at 60 cycles.

Rotor design determines whether the motor will run at synchronous speed or below, and the amount of the rpm drop. Three general classifications of induction motor rotor-designs exist, each with separate characteristics. *(CONTINUED ON NEXT PAGE)*

The Difference Is in the Rotor

Electric motors operate by induction or by commutation. In either case, it's the spinning rotor that does the mechanical work. Where they differ is in how the rotor receives its energy.

In induction motors, the rotor has no electrical contact with either the stator (field) winding or the power supply line. Instead, the rotor winding gets energy by magnetic induction across the air-gap, similar to the transfer of power from primary to secondary of a transformer. Essentially, the rotor becomes a "slipping" magnet in nonsynchronous induction motors, resulting in a turning force on the shaft.

The rotor may also be excited without utilizing the induced stator voltage, such as in the case of the permanent-magnet rotor or separately dc-excited slip ring rotor on larger machines. The rotor magnetic field then no longer slips and tends to synchronize with the revolving field. This limits induction motors to operation on alternating or pulsating current.

Commutated motors have electrical power supplied to the rotor through commutators. The commutator is actually a rectifier giving the armature a fixed magnetization direction. Commutated motors—except for universal-series motors and repulsion types—are limited to dc duty.

Several repulsion-type motors utilize both the commutated and induction principles.

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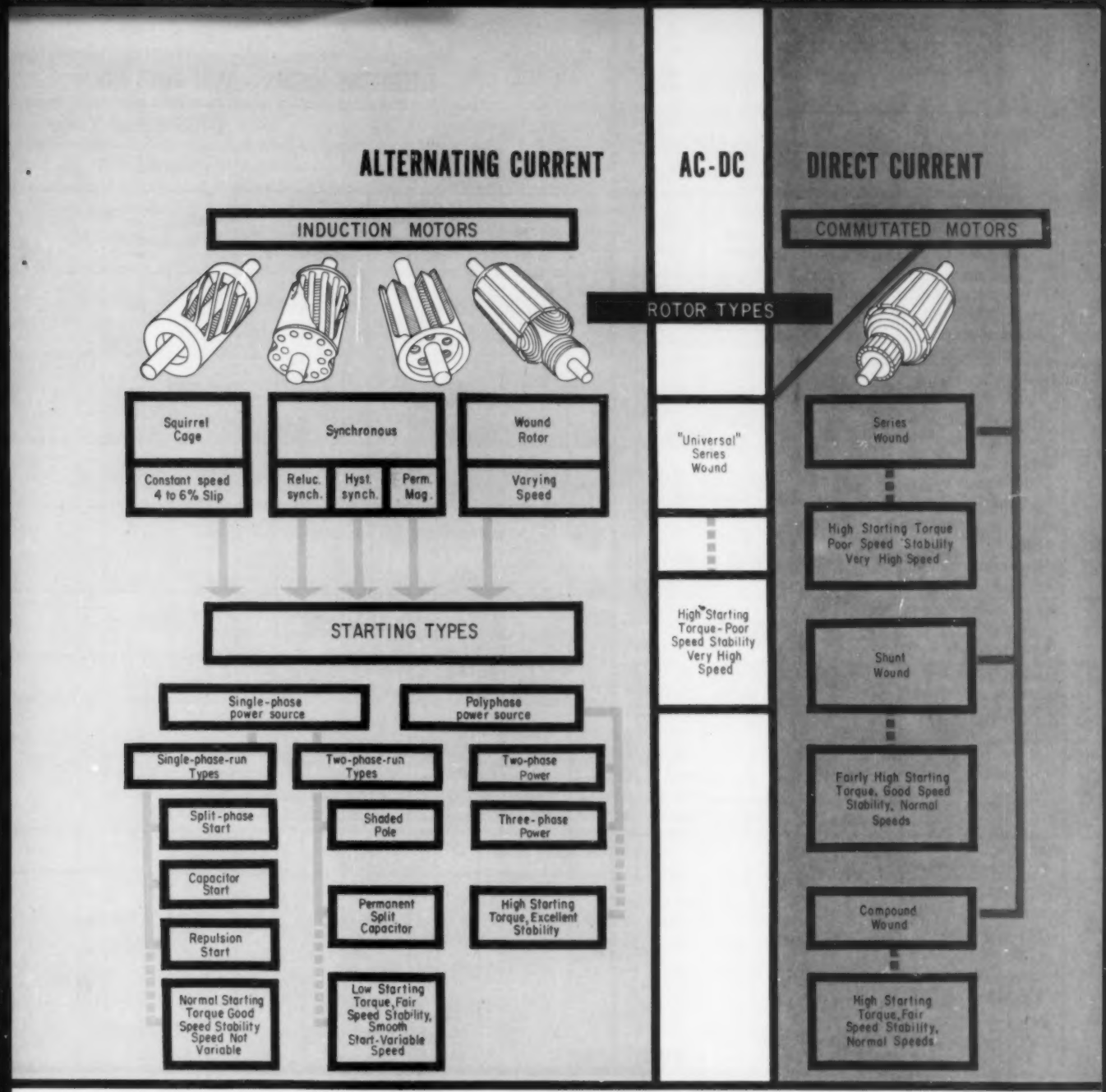
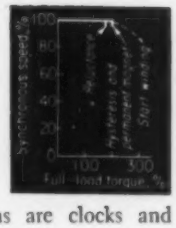


1 Squirrel-cage

These motors operate at 4 to 6% below synchronous speed and have good stability as shown by the accompanying performance curve. The practicality—therefore low cost of manufacturing this rotor type—plus the adaptability of its operating characteristics to most applications, makes it by far the most widely used ac type.

2 Synchronous Motors



Are limited to applications where absolutely constant speed is necessary despite their relatively higher cost of manufacture. Typical applications are clocks and high-accuracy timers. There are three general rotor designs—reluctance synchronous, hysteresis, and permanent magnet. With each, the rotor is designed to lock at synchronous speed and maintain the speed under all loading conditions less than pull-out.

Reluctance synchronous . . . is the cheapest, gives high pull-out torque with load. Disadvantage: pulsates sympathetically with line frequency. A solution is the hysteresis type . . . it maintains smooth speed regardless of frequency (typical application: high-quality recorder turntable) but is more sensitive to voltage change and more expensive. Permanent-magnet motor . . . operates at high efficiency and generally higher starting torque.

(CONTINUED ON NEXT PAGE)

Fhp motor

ALTERNATING MOTORS — BASIC TYPES AND

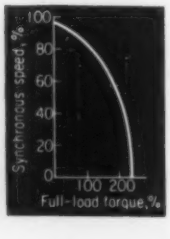
Motor Type	AC CONSTANT-SPEED (Speed Variance No Load to Full Load: 4-6%)							AC					
Rotor Type	Squirrel Cage						Wound rot. commutated	Reluctance			Hysteresis		
Start or Winding Type	Split Phase	Capacitor Start	Repulsion Start	Shaded Pole	Perm. Split Capacitor	Polyphase 3φ	Series Wound Governor	Split Phase	Capacitor Start	Polyphase 3φ	Shaded Pole	Perm. Split Capacitor	
Starting torque (%F.L.)													
High (200% up)													
Moderate (100-200%)													
Low (100% down)													
Rotation													
Unidirectional													
Reverse from rest													
Rev. from rest or run	(1)	(1)		(2)			Special						
Duty cycle													
Continuous													
Intermittent													
Starting current													
High													
Moderate	(3)												
Low													
Radio interference													
Accelerating	One click							One click					
Running													
Most practical power-output range	1/3 hp & below	Full fhp range	1/4 hp & above	Below 1/3 hp	Full fhp range		Full fhp range	1/8 hp & below	1/3 hp & below		1/50 hp & below		
Std full load speed (60/50c)													
2 pole	3450/2850			3000/2600	3250/2700	3450/2850	Speed depends on governor setting	3600/3000					
4 pole	1725/1425			1550/1300	1625/1350	1725/1425		1800/1500					
6 pole	1140/950			1050/875	1075/900	1140/950		1200/1000					
8 pole	850/---			800/---	825/---	850/---		800/---					
Adj. speed range: (F.L. speed minus %)													
Extra equipment generally required													
Starting relay (4)													
Capacitor		(5)			(5)							(5)	
Governor													
Resistor													
Rheostat or reactor													
D.P.D.T. rev. switch (6)	Either depending on mechanism												
S.P.D.T. rev. switch (6)				(2)									

NOTES
(1) Special mechanism necessary
(2) Available usually on a special basis
(3) In larger motor sizes
(4) If design does not include internal centrifugal starting mechanism
(5) Generally included as part of motor
(6) If motor is to reverse

The permanent-magnet synchronous motor has a self-excited rotor which pulls itself into synchronism through the positive force exerted by its magnets. A modification is the inductor or step motor. These give extremely low synchronous speeds and are used in control systems or as rotary step actuators. Such motors have a split segmented rotor alternately magnitized, running in a stator field with many poles. The motor can easily have as many as 96 resultant equivalent poles to give 75-rpm at 60 cycles.

3 Wound-rotor

These motors in fhp sizes are normally limited to special polyphase applications where straight-line speed-torque curves or high slip speeds are desirable. This motor type, when its cost and relatively large size can be justified, permits its rotor resistance to be varied by an external resistance supplied through slip rings. Thus, nature of the performance curve can be varied at will.



High-resistance squirrel-cage rotors achieve the same effect but rotor resistance cannot be externally varied and is limited by moldable size of the conductors. Wound-rotor motors are almost always limited to the larger sizes (½ hp and up), and are generally

CHARACTERISTICS

SYNCHRONOUS				AC ADJUSTABLE SPEED			
Permanent Magnet				Squirrel Cage		Wound Rotor	Wound Rotor Commutated
Split Phase	Capacitor Start	Polyphase	Synchronous Induction Step mot.	Shaded Pole	Perm. Split Capacitor	Polyphase 3 ϕ	Series Wound
Dependent on application and control							
				(2)			(2)
Dependent on application and control							
One click							
1/8 hp & below	1/2 hp & below	3/4 hp & below	1/50 hp & below	Below 1/6 hp	Full fhp range	1/4 hp & above	Full fhp range
Low synchronous speeds, may vary with application				3000/2600 1550/1300 1050/875 800/---	3250/2700 1625/1350 1075/900 825/---	These motors are rated by torque output at a given speed	5,000 to 10,000 rpm
				33%	50%	50%	100%
	(5)				(5)		
					4 lead 3 lead		4 lead 3 lead

DC MOTORS — TYPES AND CHARACTERISTICS

Winding Type	Series	Series Governor Controlled	Shunt	Compound
Speed Approx. speed regulation between no load and full load	Up to 70%	2-6%	10-25%	25-30%
Starting torque (% F.L.) High (200% up) Moderate (100-200%) Low (100% down)				
Rotation Unidirectional Rev from rest and run	Note	Note		
Duty cycle Continuous Intermittent				
Most practical power-output range	Full fhp			Above 1/20 hp
Normal-speed range	5000-15,000	1000-5000		
Adjustable-speed range by armature control (F.L. speed minus--%)	Completely adjustable by line voltage control from stall-no load		100%	100%
Adjustable-speed range by field control (F.L. speed plus--%)			50%	50%
Extra equipment req. Governor Rheostat (for var. speed) D.P.D.T. rev. switch				

NOTE: Available usually on special basis

used for specific polyphase applications such as high-inertia loads and variable-speed drives.

INDUCTION MOTORS—2 STARTING TYPES

When a motor operates on 3-phase current, starting is not a problem because a true rotating field is established in the stator at the instant current is introduced. Hence, 3-phase motors are self-starting, and are selected for speed and power characteristics. Often, when considering single- vs 3-phase motors, it is worth remembering that the latter offer very high starting torques and efficiencies, and small size per rating.

Single-phase power does not produce a revolving field—but rather a pulsating field in which a stalled rotor does not know which direction to rotate. Therefore, it requires a boost in the correct direction until it gains sufficient speed. Solution: a twist of the shaft; or more practical, an electrically phase-shifted start winding. The many methods of applying such winding often cause confusion to motor users.

Basically, there are two classifications of starting types—those that disconnect the starting winding from the circuit when the motor has attained speed, and those that maintain this winding in the circuit at all times. The disconnecting type has no effect on running speed characteristics previously discussed. The second type introduces a 2-phase principle of operation, and may have an appreciable influence on total performance.

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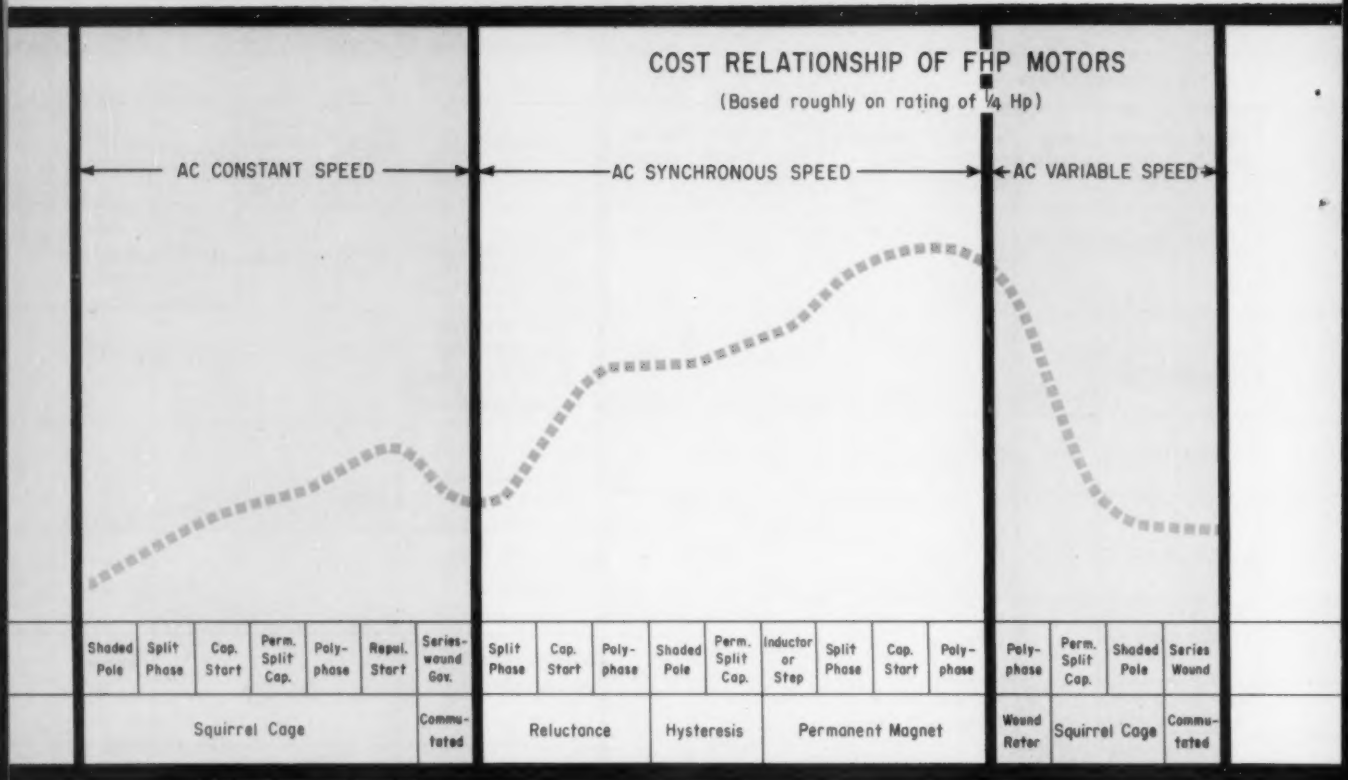
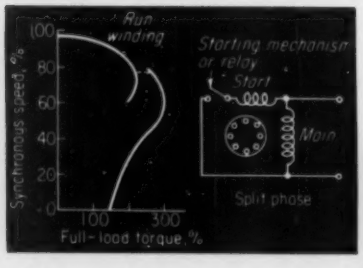


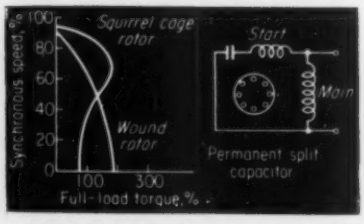
NOTE: The many variables involved in pricing motors normally preclude an accurate, pinpoint comparison. Values above are based on the relative material content of each motor type as defined by its electrical and commercial requirements. Note, however, that this comparison is based roughly on standardized motors, and that price relationships of any particular manufacturer's motors will often be found to vary considerably owing to various specific market requirements, manufacturer's level of standardization, other variables.

Single-phase-run

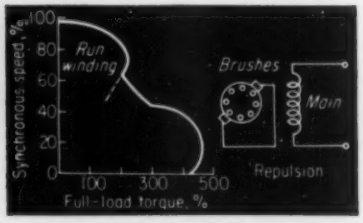
These motors are the disconnect type. They include three starting methods: speed sensing mechanism, or an external voltage or current relay. General characteristics are relatively high starting torque, good speed regulation, and unaffected running characteristics for a given rotor type.



Split phase has a separate start winding which gives a 20° to 25° phase shift by impedance difference. This is the most popular induction motor because it provides normal starting torque with minimum equipment.



Capacitor start adds a capacitor to shift the phase angle of the starting field as much as 90° from the main. Advantage: high starting torque, but is more expensive.

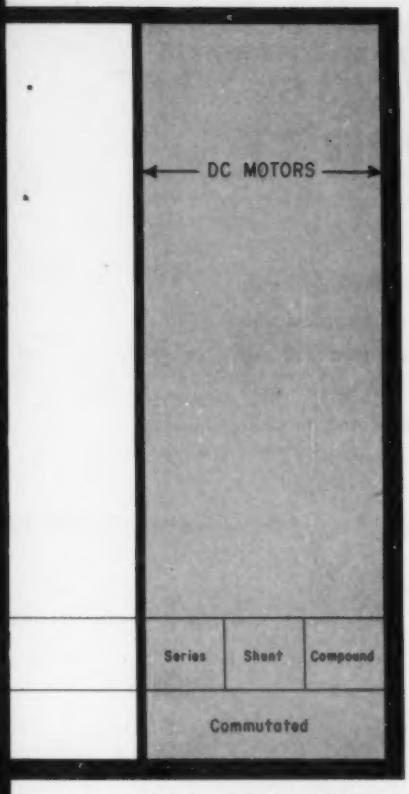


Repulsion start needs a wound rotor, commutator and short-circuited brushes to give a combination of commutated series plus induction starting. As speed increases, a centrifugal mechanism shorts the rotor windings to convert operation to the good speed regulation of the squirrel-cage principle. Other repulsion types, such as repulsion-induction and straight repulsion, use what are essentially modifications of these principles. While relatively complicated and costly, this motor offers very high starting torque, and is used in fhp frames for hard-to-start devices such as some pumps and compressors combining high starting torque with low starting current. In many cases repulsion-start induction motors have been supplanted by the capacitor-start motor.

Two-phase run

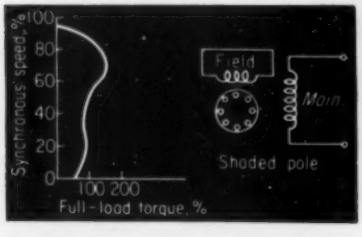
These motors, while using single-phase power supply, essentially operate on a 2-phase principle. This is a compromise between starting torque and full-load running speed. Starting torque is usually low. Any improvement causes running speed to drop

Fhp motor

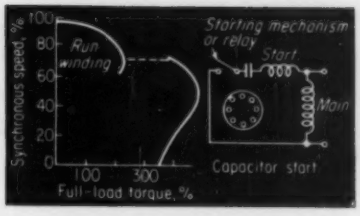


NOTE dc motors of the 3 winding types may vary throughout the range of this chart depending upon the requirements for quality, life, and other factors called for by each user industry.

proportionately. Advantage: low cost and smooth starting transition over the entire speed range.



Shaded pole has an added field. It is a short-circuited field winding which gives necessary phase shift to start the motor under light starting loads. Inexpensive to make and requiring no external starting equipment, the shaded-pole motor is one of the lowest cost electrical designs available. Characteristics: low starting torque but adaptable to adjustable speed or multispeed designs. Suited for fans, blowers and applications where low starting torque can be used.

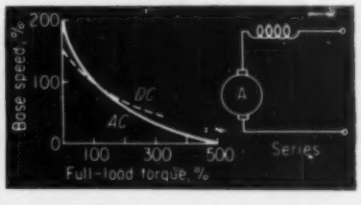


Permanent split capacitor, similar in design to the capacitor-start motors, requires a separate low-capacitance capacitor which is not removed from the circuit during operation. More expensive than the shaded pole, it can be designed with higher starting torque and better efficiency while keeping the advantage of smooth acceleration. It's often used in air moving applications, and is adaptable to varied requirements: for example, with a high-resistance rotor it takes the form of a torque-type motor, giving fairly straight-line speed torque characteristics between full load and stall. Such motors are often used to give positive resistive or holding torque. They can be built to be stalled across the line without damage for holding applications, and are adaptable to reversing operation.

COMMUTATED MOTORS—3 TYPES

With direct electrical connections between rotor and stator, commutated motors are identified by the nature of the stator-rotor connections—series, shunt or compound.

Series-wound

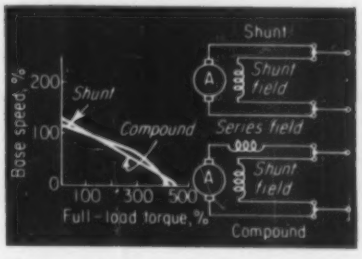


These motors have field and armature windings connected in series with line voltage. When it can produce about the same full-load torque and speed at any frequency from 60 cycles to dc, it is known as a universal motor.

In ac applications it has the inherent advantages of extremely high speed and starting torque—so it offers the smallest size per output rating of any 60-cycle ac motor designed. Limiting factor: very poor speed regulation, although a governor can overcome this where other advantages dictate its use. Two other factors: Brushes and commutator increase motor maintenance; high operating temperatures and brush wear usually demand intermittent duty-cycle.

In dc applications, high starting torque and comparable high speed—a factor that allows much power in a small package—are outstanding features. Again, poor speed regulation is a drawback. Governors are seldom used, since good speed stability may be obtained by using another type winding.

Shunt and compound-wound



These motors are the general-purpose workhorse types for dc operation—normally they are found in adjustable-speed drive applications. Compared with series-wound, they offer low speed (5000 rpm and below) but much better speed regulation and good efficiency.

Brushes of the shunt motor are shunted across the power input leads. This motor offers the best speed stability of the dc types, but with a slight sacrifice of starting torque compared with compound and series types.

The compound motor is a compromise—a shunt motor with a few series turns added to its shunt field. Result is improved starting torque and somewhat greater speed variation with load.

REPRINT of this article can be obtained for your reference file by checking No. E61 on one of the Reader Service cards inside back cover. For other reprints available see "Current Reprints" listing in this issue on page 151.

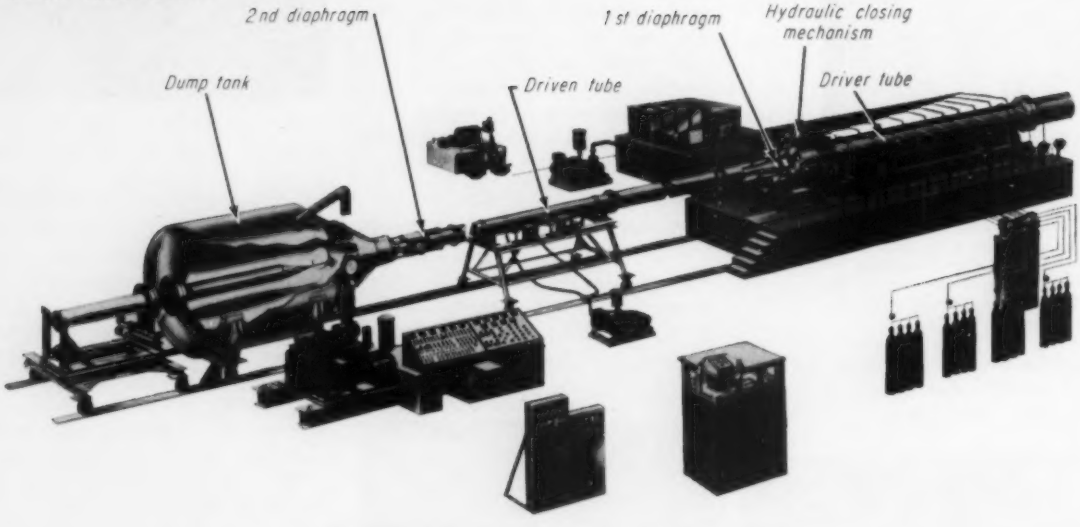
EDITOR'S NOTE: Mr. Morgan was also author of the article, "Check These Features Before Applying Your FHP Motor," Dec. 22 '58, p. 60, which discussed salient mechanical features and tests.

If present article dictates the use of a polyphase motor, check "Let the Load Be Your Guide When Selecting Polyphase Motors," Aug 18 '58, p 58 to find correct motor based on torque, slip and duty cycle requirements.

WITH RESEARCH EQUIPMENT—
SAFETY FIRST

Design's touchiest job is providing apparatus for scientists and engineers who explore the unknown. Author outlines steps that will put safeguards where needed, and gives case history showing how testing a prototype paid off by spotting a dangerous oversight.

CASE HISTORY:



DESIGNING SAFETY INTO A SHOCK TUNNEL

The shock tunnel at GE's Aerosciences Laboratory, Philadelphia, is used to study the effect of hypersonic flow on various models. Basically, it is a driver tube coupled to a driven tube but separated from it by a copper diaphragm. Hydrogen, oxygen, and helium are introduced into the driver tube, raising its pressure to a predetermined level. When the mixture is ignited, increased pressure ruptures the diaphragm, sending a piston-like shock wave down the tube. Gas ahead of the wave is heated and compressed; gas behind expands and cools. The high-pressure pocket of gas created at end of the tube breaks a second diaphragm and expands through a nozzle into the test section and dump tank.

In setting **specifications** for the 6-in. tunnel, close cooperation between scientists and engineers was obtained by having them work as a team. First problem: What **stresses** could be expected in the driver and driven tubes? Max working pressure for the driver was set at 10,000 psi. But careful analysis of the combustion process, the possibility of local detonations and other stress-increasing effects, indicated that local pressure, in areas large enough to be considered serious, might go to 20,000 psi, though probably no more. Therefore, the driver was designed to withstand max pressure of 20,000 psi with a safety factor of 1.4 based on yield. Also, a shear plug (designed to break when pressures exceeded 22,000 psi) was placed in end of the driven tube.

Expected pressure in the driven tube could not be defined as clearly because no one had operated a tube this large; so it was designed for max anticipated pressures and with a safety factor of 2. The dump tank was even more of an enigma. An ultraconservative estimate placed max pressure at about 150 psi, but all other calculations indicated less than 50 psi. To meet installation schedule, this tank was designed for 100-psi working pressure—but with orders to operate it at low pressure until actual pressures were established. In addition, a 150-psi hydrostatic test was specified before acceptance.

Codes require that where hydrogen is used, all electrical apparatus must meet special requirements; fire prevention and

J W REID, *Advanced Aerodynamics Laboratory, General Electric Co*

When Ben Franklin performed his famous experiment with kite and key, he took what seems today an unnecessarily foolish risk. But modern researchers often work with equipment that is potentially just as lethal and involves just as many unknown hazards. When scientists study rocketry, atomic energy and high-speed flight, for example, they must occasionally take calculated risks. With science exploring the unknown, not every hazard can be eliminated. But a safety-oriented designer will be on guard and can usually incorporate modifications that will protect the researcher against harm.

The dilemma of safe design is a familiar one--how to make equipment safe, economically, without sacrificing performance or delaying the project? Best way to couple safety with speed of accomplishment and reasonable cost is to aim for a safe design from the very beginning.

Specifications. The scientist knows what the new equipment should do, the dimensions he wants, the critical spots, the hazards involved. It is up to the designer to concoct the safe, working hardware without setting specifications that are so tight that the project cannot be completed in time. Close liaison is important—in research and development, a breakthrough can occur overnight and create radical changes. Therefore, specifications should be cleared by the scientist just before release and if there is a sizable delay between final release and start of design, they should be reviewed again. Such consultation can save many manhours in the long run.

One liaison answer is to have scientists and engineers

(CONTINUED ON NEXT PAGE)

control codes are also severe. The tunnel was to be located in a large testing lab, and cost of converting it to meet safety requirements was prohibitively expensive. Problem was solved by housing the driver in a special room tacked on to an outside wall of the lab and using a small, existing building adjacent to it for gas supply. The wall between main building and driver-house was strengthened; explosionproof doors and a blow-out roof were installed on both small buildings.

To combat **secondary hazards,** it was decided to clear the area around the tube of personnel during loading and firing. A wall was erected on both sides of the tube to protect personnel who might be working with other equipment in the same section of the building. As an additional safety feature, a control house with bulletproof glass was erected where it would give the operator a clear view of the entire area before he fired the tunnel.

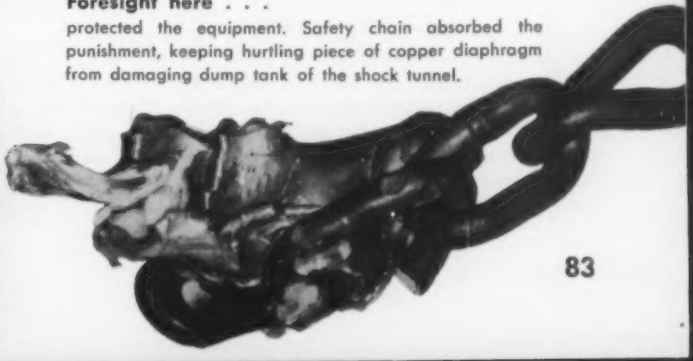
Secondary hazards were rechecked when modifications and additions were made to the equipment. For example, after it had been in use for a while, the tube was modified so that the entrance diameter of the nozzle at end of the driven tube was same diameter as the tube. This, however, meant that if leaves of the copper diaphragm broke off, they might be driven into the end of the dump tank. To avoid such accident, a fragmentation catcher consisting of heavy steel chain was hung at the rear of the dump tank. When a fragment of the diaphragm did go flying it had enough energy to break the chain but did no damage to the tank.

A **prototype** of the driver coupled to a short driven tube was tested in one of the well-protected concrete pits at the Malta Rocket Test Station, New York. The tests were not only for equipment safety but to check and debug the mechanical equipment, auxiliary components and controls, and to determine instrumentation and operating techniques. One minor accident illustrates the value of testing a prototype.

Because of a speedup, tests were being made seven days a week. On a Sunday, one of the four hydraulic cylinders holding the diaphragm began leaking and, because no one from the regular maintenance crew was available for repair, a run was made without using this cylinder. The run was made at fairly high pressure and the force of the explosion opened the seal between driver and diaghragm instead of rupturing the diaphragm. High-pressure gas escaped into the test cell and blew an aluminum-cased door off its hinges, throwing it about 15 feet before it came to rest against a steel protective barrier. Damage was limited to the door and some small auxiliary pieces but the incident led to installation of an interlock which made it impossible to fire the tunnel unless all hydraulic cylinders were operating at correct pressure. ■

Hindsight here . . .
proved value of testing prototype and led to change in design for firing the tunnel. This aluminum-cased door was hurled 15 feet when high-pressure gas escaped into test cell.

Foresight here . . .
protected the equipment. Safety chain absorbed the punishment, keeping hurtling piece of copper diaphragm from damaging dump tank of the shock tunnel.



work as a team. Or if the company is large, and anticipates continuing design of R & D equipment, a group of engineers specializing in such design can be created and assigned as projects arise. Another solution: Bring in an outside consulting firm that will stay with the group through the project.

Stress analysis. When a theory is new and untried, the forces and consequently the stresses that will develop in the test equipment are often unknown. Arbitrarily increasing the safety factor may only handicap the experiment. It's better to determine maximum range of forces first, then set safety factors. When forces can be predicted with confidence, use standard safety factors; if in some doubt, use forces that represent most conservative design and add a slightly higher-than-usual safety factor. If there is serious doubt use maximum anticipated force and apply higher-than-usual safety factor, but limit the equipment to light loads until all forces have been found and checked. Provide weak points (safety valves, shear pins) where failure will not be dangerous and tests unduly delayed because of accident.

Codes. Laws require that buildings and equipment conform to safety regulations. Certain precautions must also be taken when working with hazardous materials. Far from hindering good design, the codes can point out hazards early enough to prevent costly redesign later. Also, when they stimulate engineers into examining reasons behind the requirements, additional safety—and even better design—can result.

Secondary hazards. Designing to avoid secondary hazards means "anticipating the unpredictable." Suppose a careless operator cross-threads a bolt into a high-pressure fitting. A careful designer will have foreseen this and provided a shield to stop metal fragments flying around the room. Such situations, as dangerous as the more predictable failures, actually have a greater chance of happening than failure in a closely watched critical area.

Testing components and prototypes. Before design becomes final, it is probable that tests will be made on individual components. With standard parts and hardware, routine tests to be certain that components meet explosionproof requirements, ASME Boiler Code, etc., are generally sufficient. Special tests on purchased parts should be made by the vendor or fabricator—he already has the necessary test equipment in his shop.

Safety tests on a prototype require more consideration; building a prototype exclusively for safety tests can delay the program and cost extra money. But because a prototype is often built to test functional operation, safety tests can be made at the same time. If a prototype is not built, of course, components should be tested more thoroughly. ■

Your Index is Ready

The Product Engineering index for the last half of 1958 is now available. It covers all editorial material published in the 26 Design and R & D issues between July and December 1958. Combined with the previously published index for the 26 issues from January to June and the bound-in index for the annual Design Digest, these indexes cover more than 2450 highly compressed editorial pages published in 1958.

This represents the researching and evaluating, analyzing and writing labor of 22 men and women, who average over two full days' work to produce the copy for one printed page. It could be done faster, and many publications do, but the quality, accuracy and competence would suffer proportionately.

In addition to feature articles and staff reports—both staff-written and contributed—the Index covers these staff-written departments: Developments to Watch, The Engineering Week, Perspectives, Editorials, Points of View, Trends in Appearance Design, Design Features in New Products, Design Roundups, Reference Book Sheets, Tangents, Significant Components and Materials, and Abstracts.

The index for the first half of 1958 was expanded to include an alphabetical listing of all organization and company references; this feature also appears in the new index now and becomes a permanent addition to the indexing service.

So here is your current index. It's free —just write "Index Vol 29-II" on one of the reader service cards bound in this issue. Fill in your name and address, and mail. There are still some copies of the Index for the first six months of 1958 available. If you haven't already ordered one, simply add Index Vol 29-I in the same place. Copies will be sent as long as they last.

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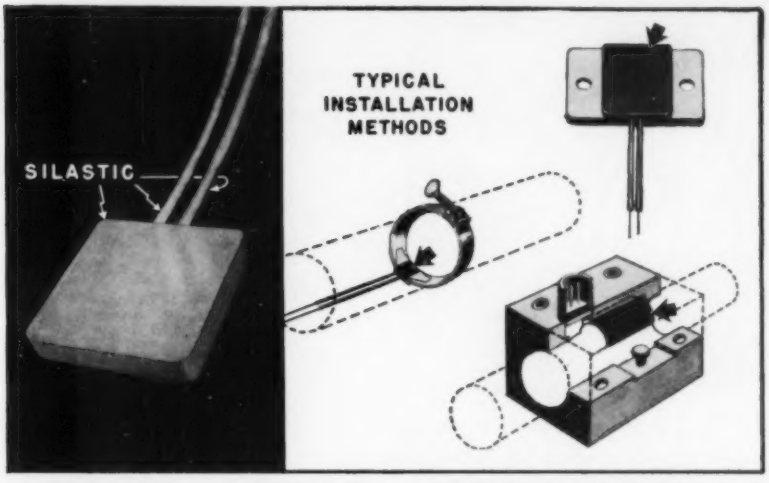
SILICONE NEWS

for design and development engineers • No. 58



OFFSETS TOUGH SURROUNDINGS

Even the most delicate instruments can be counted on to give reliable service in hazardous surroundings when protected with Silastic®, the Dow Corning silicone rubber. Here's how encapsulation in Silastic seals in better performance.

The new Strapon surface resistance thermometer, recently developed by Arthur C. Ruge Associates, Inc., Cambridge, Mass., illustrates this point. Consisting of a resistance element bonded to a stainless steel surface only 0.002 inches thick, the thermometer and lead-in wires are fully cushioned and protected against the elements by Silastic, the Dow Corning silicone rubber.

Silastic protects this thermometer at temperatures ranging from —100 to 500 F . . . assures accuracy in the presence of vibration, radioactivity, high humidity, water, alcohols, salts, mineral and vegetable oils, many acids and alkalies. As a result, Strapon thermometers are used to measure surface temperatures in applications ranging from in-flight missile testing to flow control monitoring for the food and chemical processing industries.

For easy mounting on any surface, Strapon thermometers can be bonded to a variety of clamps and brackets with Silastic adhesive. *No. 593*

BETTER MOISTURE SEAL

When long-lasting silicone compounds are employed, sealing is frequently made easier and more effective. Wico Electric Company, West Springfield, Mass., furnishes an example.

Wico manufactures magneto coils for the ignition systems of gasoline engines on popular-make outboard motors, chain saws, lawn mowers and other gasoline-engine driven products. Moisture, corona and corrosion at the connection between high tension lead wire and coil has always been a problem.

Keeping moisture out, however, has been easy since Wico started using Dow Corning 3 Compound. Applied liberally on the lead, the greaselike silicone compound lubricates mating parts . . . flows readily into existing voids when the ignition lead wire is screwed into place in the magneto coil body. The result is a moistureproof seal between the neoprene jacketed ignition lead and the molded plastic body.

Nonoxidizing, nonmelting and nongumming, this silicone compound protects indefinitely against moisture, corona and corrosion, and is noninjurious to rubber or plastics. If the ignition lead is removed for repair or replacement, the connection is easily re-sealed with another application of Dow Corning 3 Compound. *No. 594*

New: 1959 Guide To Silicones

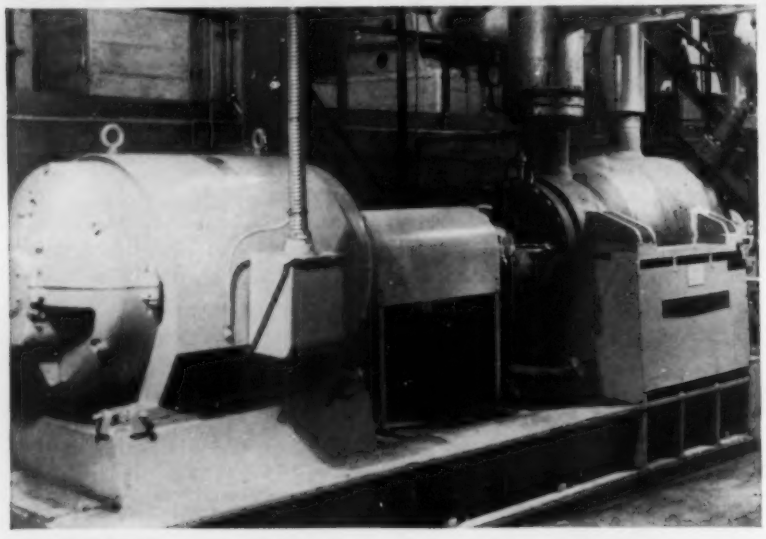
Now available. The 1959 Reference Guide to all Dow Corning silicone products, including fluids, lubricants, resins, adhesives, varnishes, dielectrics, rubber, water repellents, textile finishes, leather treatments and other specialized forms. A "must" for designers, you can obtain your Free Copy by circling . . . *No. 595*

New Aid For Missilemen

For product designers whose projects are related to missilery, the new brochure "Silicones in Missile Design" offers practical information on silicones and their uses. Particular attention is devoted to areas that point up how silicones aid miniaturization, weight reduction, and reliability. *(Cont. Pg. 2)*

FOR DATA RELATING TO THESE ARTICLES, CIRCLE REFERENCE NUMBER IN COUPON ON NEXT PAGE

MORE



MODIFY SPECS: SAVE $28,000

Designers of pumps, fans, blowers and compressors can often cut costs and improve reliability by specifying silicone insulated drive motors. Here's how modifying the specification to include silicone insulation saved 38% on the original cost of four large motors.

Intended for service in a dusty, humid atmosphere, totally-enclosed, fan-cooled construction was originally specified for pump and fan drive motors. These costly enclosures were specified to isolate the induction motor's stator coils from the contaminated atmosphere.

A far more economical solution was found through the use of open, drip-proof enclosures. Sil-Clad motors, built by Electric Machinery and Manufacturing Company with silicone rubber insulated coils, had self-protecting insulation systems that made less costly motor enclosures adequate. A savings of $28,000 resulted for the Minnesota and Ontario Paper Company, International Falls, Minnesota. What's more, the motors have an even greater service factor (overload capacity) than the originally-specified drives because of the excellent thermal stability of Dow Corning Silicones.

Electric Machinery's self-protecting insulation system is fabricated by double-wrapping coils with semi-vulcanized tape made from Silastic®, the Dow Corning silicone rubber. The tape system is then cured, forming a resilient, moistureproof, one-piece insulating jacket with excellent dielectric properties.

This $28,000 saving resulted from specifying silicone insulation systems for only four motors. Two are 900-hp boiler feed pump motors, the third a 600-hp induced draft fan motor, and the fourth, a 300-hp forced draft fan drive motor. *No. 596*

MISSILES *(Continued)*

The new eight-page brochure covers all physical forms of Dow Corning Silicones . . . rubbers, resins, dielectrics, fluids, greases and compounds.

Fully illustrated, the brochure describes how missile components are already utilizing silicones, and suggests many new areas of application. It is organized for easy reference, enabling you to locate, at a glance, any material or application that interests you. All in all, a very valuable brochure. Free on request . . . *No. 597*

new literature and technical data on silicones

DO YOU KNOW HOW silicone resins, rubber, oils and greases are being used to advantage in appliances? A six-page reprint from *Electrical Manufacturing* relates how extreme temperature resistance properties of silicones have been used to improve the performance of toasters, refrigerators, irons, portable power tools, percolators and other appliances. *No. 598*

KEEP 'EM COOL WITH SILICONE FLUIDS. Designers of electronic assemblies are using silicone fluids as coolants to solve problems created by extreme environmental conditions and miniaturization in control circuitry of aircraft, missiles, submarines, and industrial communication systems. A new data sheet contains complete information for designers. *No. 599*

THREE TO ONE . . . Sylkyd® magnet wire enamel is equally suitable for 180 C, 155C, and 130 C electrical systems. Wire enameled with Sylkyd enables equipment to withstand overloads, provides more power per pound, has longer shelf life, and withstands difficult operating conditions. Excellent size factor and good handling properties simplify design. Further information is available in a 4-page, illustrated brochure. *No. 600*

THE PROS AND CONS of reactive silicone resin intermediates in paints and varnishes are presented in an eight-page reprint from *Paint and Varnish Production*. Graphs and tables illustrate how resistance of copolymers to heat and weathering, as well as film integrity and strength, are improved by silicones. *No. 601*

COMPLETE SELECTOR — Recognized for their reliable, uniform performance in viscous damping, springing, coupling, and related mechanical applications, silicone fluids are now easy to select because of an up-to-date, file-size engineers' guide. Published as a design service by Dow Corning, this reference is a "must" for advance development research engineers. *No. 602*

SOLVENTLESS, THERMOSETTING RESINS. Dow Corning R-7501 and R-7521 are clear, tough silicone materials used for impregnating, encasing, and potting electrical and electronic units designed for high service temperatures. Used separately or blended to any desired viscosity, the good physical and electrical properties, water resistance, and heat conductivity of these resins suggest their usefulness in fabricating cast dies and molds, as components or additives for other resins used to formulate protective coating vehicles or molding compounds. *No. 603*

Dow Corning Corporation, Dept. 8613, Midland, Michigan

Please send me: 593 594 595 596 597 598 599 600 601 602 603

NAME _____

TITLE _____

COMPANY _____

STREET _____

CITY _____ ZONE ____ STATE ____

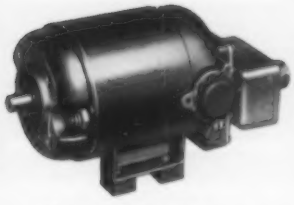
SILICONE NEWS is published for design and development engineers by

first in silicones

Dow Corning CORPORATION
MIDLAND, MICHIGAN

ATLANTA BOSTON CHICAGO CLEVELAND DALLAS LOS ANGELES NEW YORK WASHINGTON, D. C.
CANADA: DOW CORNING SILICONES LTD., TORONTO GREAT BRITAIN: MIDLAND SILICONES LTD., LONDON FRANCE: ST. GOBAIN, PARIS

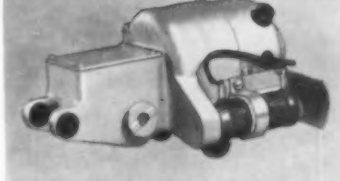
PASSES TESTS WITH FLYING COLORS



Aircraft de-icing pump motor.

Impact concrete drill motor.

Explosion-proof vacuum unit.



Gear motor for slow-speed drive.

If you are interested in any of the above motors write and we shall be glad to send full information.

. . . equal dependability for your product

One of the recent Lamb Electric developments is a motor to drive submerged pumps on military aircraft—for transfer of fuel from reserve to engine tanks.

For such an important application, motor reliability far beyond that normally called for was needed. To insure this degree of reliability in its actual operation of driving the submerged pump, test requirements for the motor were exceptionally rigorous.

As the result of advanced engineering and design, greatly increased brush life, and ability to operate at extremely high temperatures and withstand severe shock tests, the motor passed gruelling tests with flying colors.

The skill and experience exemplified here is available to your company to provide dependable power for *your* new or redesigned products.

THE LAMB ELECTRIC COMPANY • KENT, OHIO

A Division of American Machine and Metals, Inc.

In Canada: Lamb Electric—Division of Sangamo Company Ltd.—Leaside, Ontario

Lamb Electric

SPECIAL APPLICATION FRACTIONAL HORSEPOWER **MOTORS**

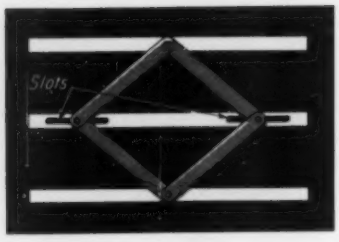
←CIRCLE 145 READER SERVICE CARD

CIRCLE 146 READER SERVICE CARD

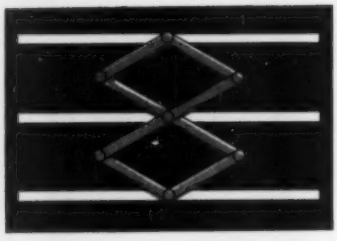
12 EXPANDING and

Parallel bars, telescoping slides and other mechanisms that can spark answers to many design problems.

FEDERICO STRASSER
Mankowitz & Strasser, Santiago, Chile

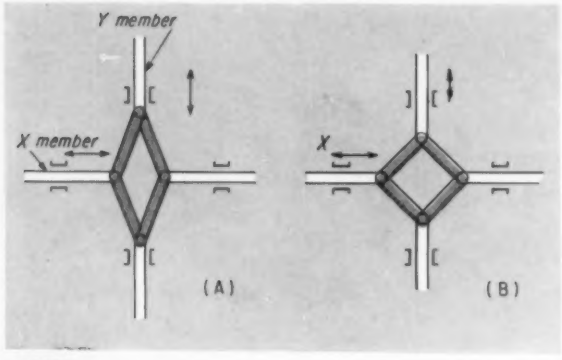


1



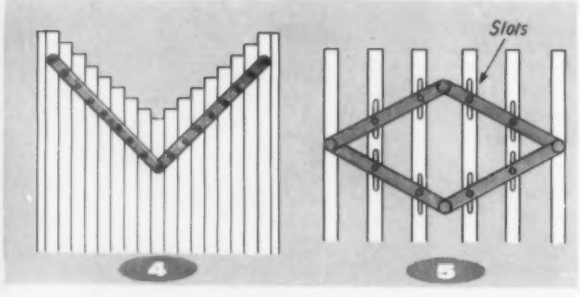
2

Expanding grilles . . .
are often put to work as a safety feature. Single parallelogram (1) requires slotted bars; double parallelogram (2) requires none—but middle grille-bar must be held parallel by some other method.



3

Variable motion . . .
can be produced with this arrangement. In (A) position, the Y member is moving faster than X member. In (B), speeds of both members are instantaneously equal. If the motion is continued in same direction, speed of X will become the greater.



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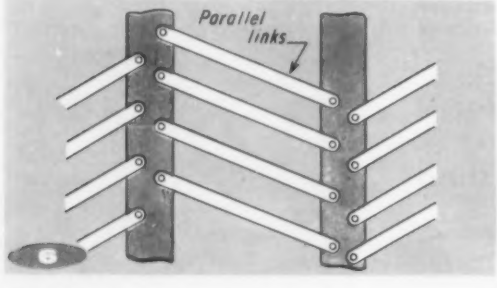
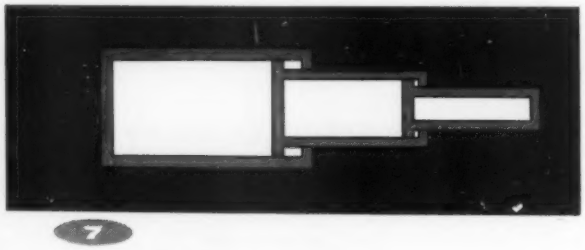


6

Multi-bar . . .
shutters, gates, etc. (4) can take various forms. Slots (5) allow for vertical adjustment. Space between bars may be made adjustable (6) by connecting the vertical bars with parallel links.



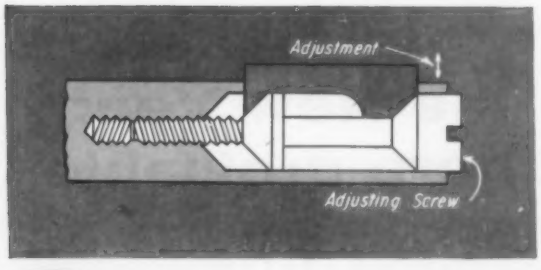
7

Telescoping devices . . .
are basis for many expanding and contracting mechanisms. In arrangement shown, nested tubes can be sealed and filled with a highly temperature-responsive medium such as a volatile liquid.

CONTRACTING DEVICES

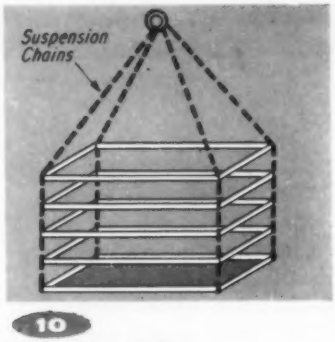
8

Nested slides . . .
can provide extension for machine-tool table or other designs where accurate construction is necessary. In this design adjustments to obtain smooth sliding must be made first, then the table surface must be levelled.



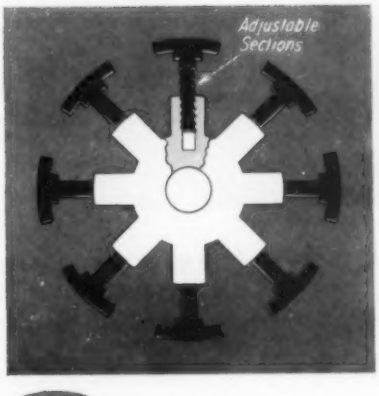
9

Expanding mandrels . . .
of the circular type are well-known. Shown here is a less common mandrel-type adjustment. Parallel member, adjusted by two tapered surfaces on screw, can exert powerful force if taper is small.



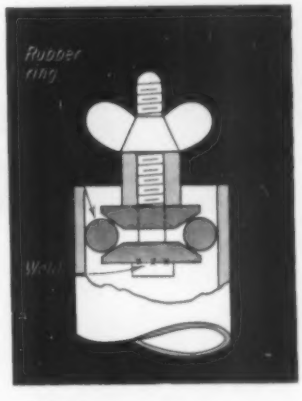
10

Expanding basket . . .
is opened when suspension chains are lifted. Baskets take up little space when not in use. Typical use for these baskets is for conveyor systems. As tote baskets they also allow easy removal of contents because they collapse clear of the load.



11

Expanding wheel . . .
has various applications besides acting as pulley or other conventional wheel. Examples: electrical contact on wheel surfaces allow many repetitive electrical functions to be performed while wheel turns; dynamic and static balancing is simplified when expanding wheel is attached to non-expanding main wheel. As a pulley, expanding wheel may have a steel band fastened to only one section and passing twice around the circumference, thereby allowing adjustment.



12

Pipe stopper . . .
relies on bulging of rubber ring for its action—soft rubber will allow greater adjustment than hard rubber, and also conform more easily to rough pipe-surfaces. Hard rubber, however, withstands higher pressures. Weld screw head to washer for leaktight joint.

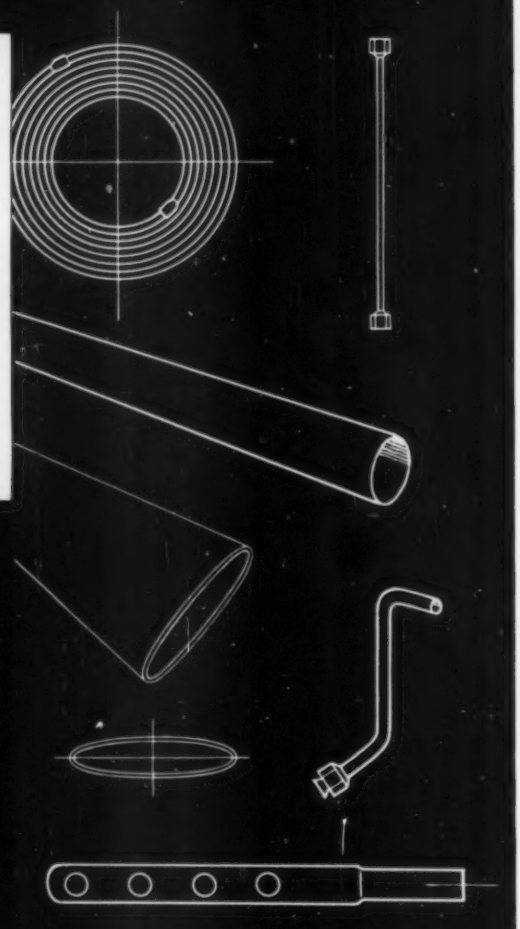
PLANNED FOR PRECISION

Resolve to make the New Year more profitable

with versatile dependable

H & H

service



START THE YEAR RIGHT by calling your nearest H & H representative *right now*. You will find that *one* call to *one* plant for all your tubing needs—from fabricated parts to coils to straight lengths—can save you ordering time and speed delivery. Dealing with a *dependable* tubing source such as H & H also means your specifications will always be strictly adhered to, thus saving you costly production delays and after-the-sale servicing.

H&H TUBE AND MANUFACTURING CO.

271 N. Forman Avenue, Detroit 17, Michigan • Offices from Coast to Coast

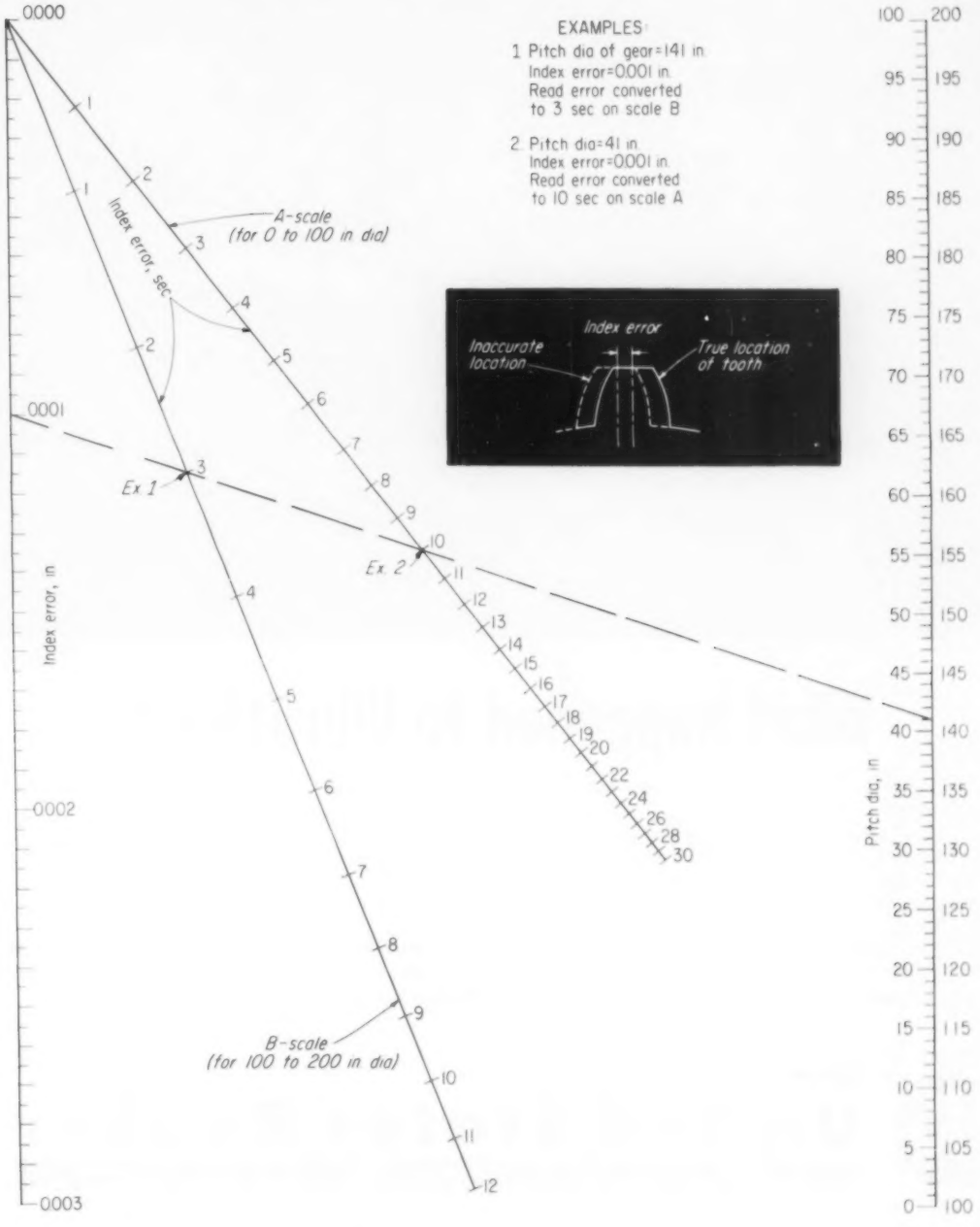
METALFLO LOCKSEAM COIL STRIP SEAMLESS TUBING TUBULAR PARTS

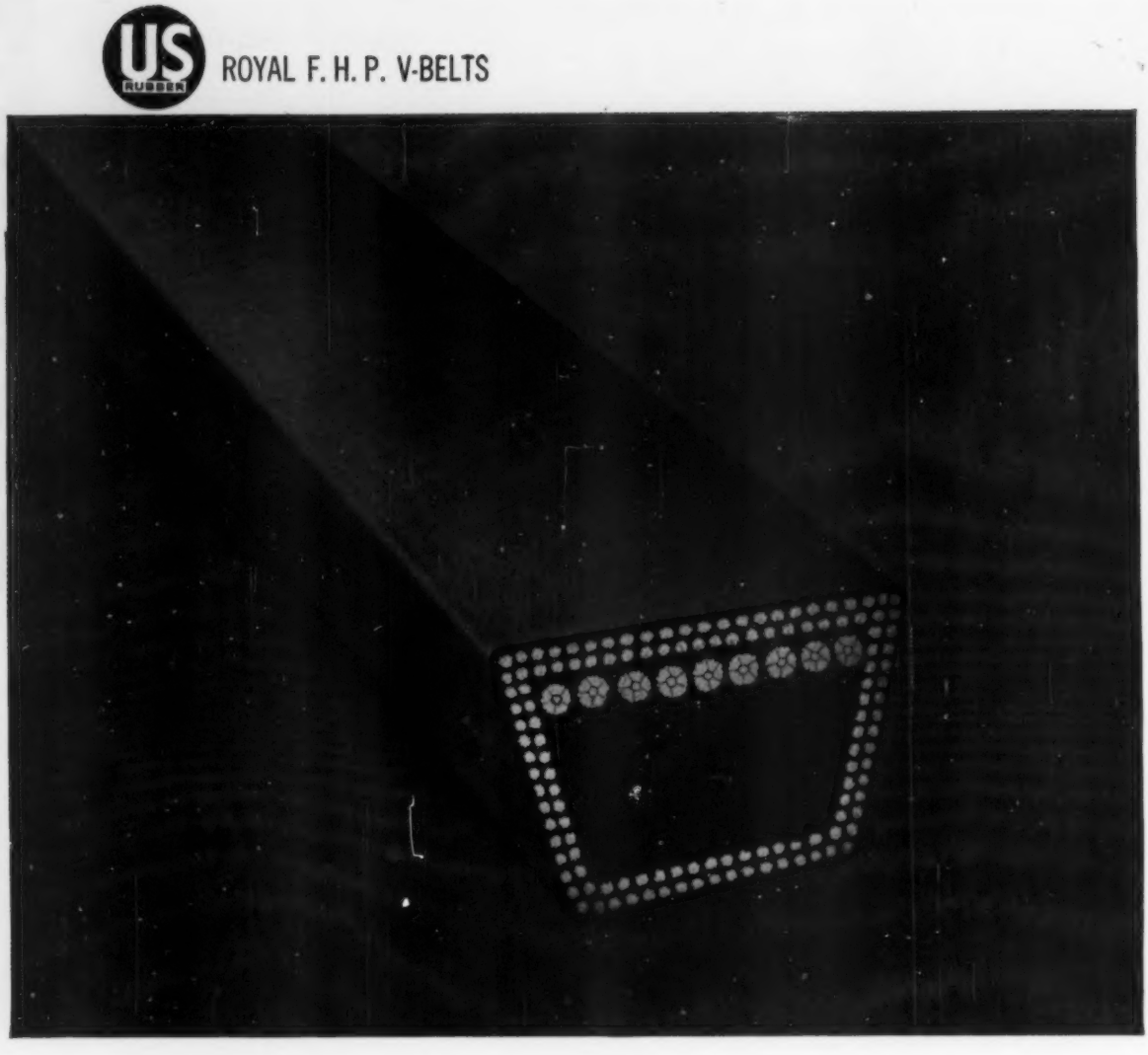
linear to angular conversion of . . .

GEAR-TOOTH INDEX ERROR

For pitch diameters up to 200 in., chart quickly converts index error from ten-thousandths of an inch to seconds of arc.

HAROLD R RONAN JR, *Research Engineer, Gould & Eberhardt Inc, Irvington, NJ*





ROYAL F. H. P. V-BELTS

What happened to Vibration?

U.S. Royal fractional horsepower V-Belts bring vibration to the vanishing point.

• Cords are built in by an error-proof electronic process that guarantees that each cord pulls its share of the load, thus prolonging cord life.

• New and advanced rubber compounds and molding methods produce the smoothest of surfaces... holding friction to a minimum. The result is smooth, almost silent balanced operation with virtually no vibration.

Advanced developments such as these have given "U. S." Royal V-Belts an acceptance unequalled in the industry.

U.S. Royal V-Belts are made in the world's largest, most modern transmission belt factory and are designed by a staff of power transmission technicians unsurpassed in skill and experience.

• • •

When you think of rubber, think of your "U.S." Distributor. He's your best on-the-spot source of technical aid, quick delivery and quality industrial rubber products.

Mechanical Goods Division

United States Rubber

WORLD'S LARGEST MANUFACTURER OF INDUSTRIAL RUBBER PRODUCTS

Rockefeller Center, New York 20, N.Y. In Canada: Dominion Rubber Company, Ltd.

HELICAL-SPRING DESIGN CHART . . .

. . . gives quick answers for steel springs

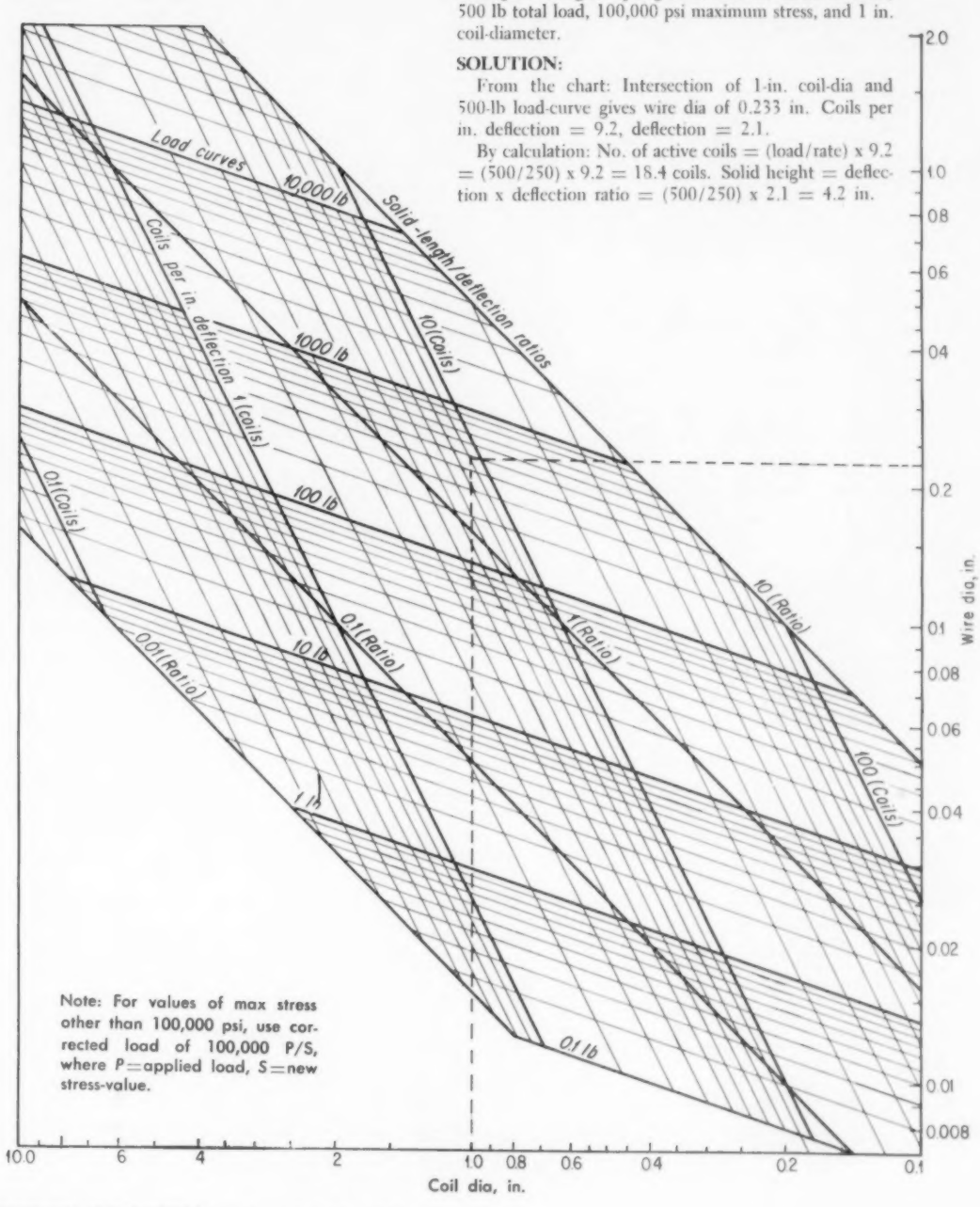
CHARLES TIPLITZ, *Chalon Consulting Engineers, Cedar Grove, NJ*

Example. Design a spring of 250 lb/in. deflection-rate, 500 lb total load, 100,000 psi maximum stress, and 1 in. coil-diameter.

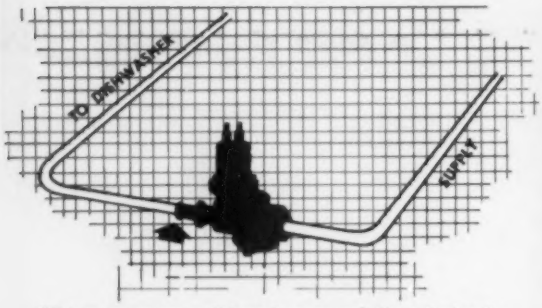
SOLUTION:

From the chart: Intersection of 1-in. coil-dia and 500-lb load-curve gives wire dia of 0.233 in. Coils per in. deflection = 9.2, deflection = 2.1.

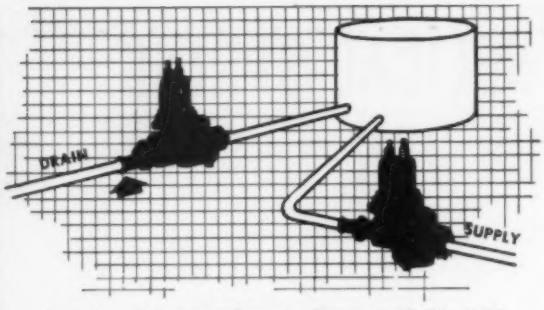
By calculation: No. of active coils = (load/rate) x 9.2 = (500/250) x 9.2 = 18.4 coils. Solid height = deflection x deflection ratio = (500/250) x 2.1 = 4.2 in.



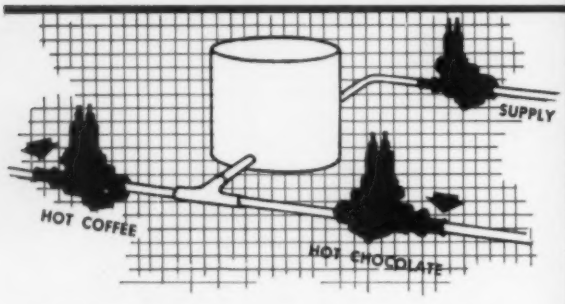
Note: For values of max stress other than 100,000 psi, use corrected load of 100,000 P/S, where P = applied load, S = new stress-value.



Hot water enters a dishwasher several times during its wash-rinse cycle. The control? Detroit Controls' S-25 Solenoid valve.



An automatic water softener recharges itself. The S-25 valve and a timer simplifies the regeneration process.

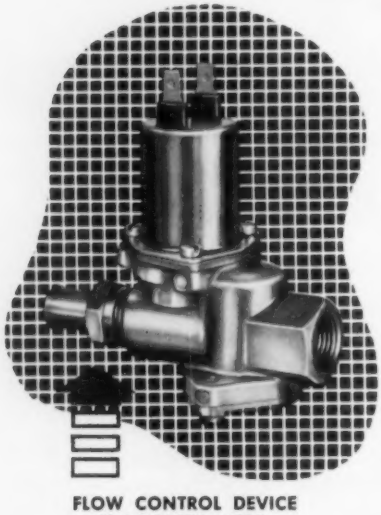


Put a dime in a vending machine. You get your choice of hot coffee or hot chocolate. There's an S-25 controlling the hot water to each—still another controlling the master supply entering the machine.

IT'S YOUR TURN! Doodle your own piping arrangement here. It's dollars to doughnuts that if you have a varying water flow control problem, the S-25 will help you do a better job.

NEW DETROIT SOLENOID
GIVES CONSTANT WATER FLOW

from 1/4 to 6 gpm—2-1/2 to 200 psi—up to 180°F
(Up to 200° For Special Applications)



FLOW CONTROL DEVICE IS LOCATED HERE.

Here's a new valve that will positively open — positively close — time after time after time. Detroit has designed it with flexibility in mind. For example, the flow control device in the outlet connection assures accurate delivery of water quantity regardless of varying supply pressures. It also is available with any of three different connections: pipe, tubing or hose. The S-25's unique construction permits accurate volume control when mounted in any position. There is a wide variety of brackets available. It has a large, integral, easy-to-get-at, easy-to-clean strainer and features waterproof, interchangeable coils for all standard AC voltages. Available with top or side spade terminals or pigtails. It's listed by the Underwriters' Laboratories.

* * *

We know of the three applications above and we'd like to know about yours. Sketch where this valve could fit into your system. Mail it to us and we'll shoot a quote right back to you. Or if you wish, we'll send a Detroit representative out right away. Just write to Detroit Controls Division of American-Standard, 5900 Trumbull Ave., Detroit 8, Michigan.

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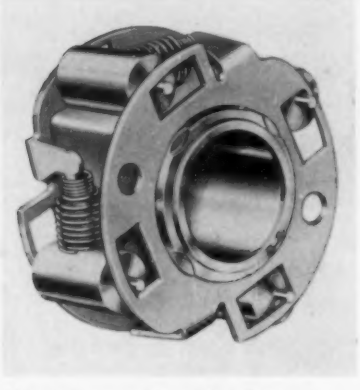
American-Standard
DETROIT CONTROLS DIVISION

Solid film lubricant . . .

contains small particles of lead, tin and graphite and, because it is semiporous, absorbs oil and acts as a reservoir against metal-to-metal contact under high loads and during long shutdown periods. Also compatible with additives in modern greases and oils. First developed for use on titanium under loads so heavy that oil or grease alone was inadequate as a lubricant. Typical applications include spherical bearings, clutch assemblies, leather oil seals, spline assemblies, bearing cages, sleeve bearings, piston cylinders, valve stems and hydraulic actuator parts. $7.50 per lb in concentrate form. Cost, in use, is about 3¢ per sq ft. Available immediately. **Electrofilm Inc, PO Box 106, North Hollywood, Calif.**

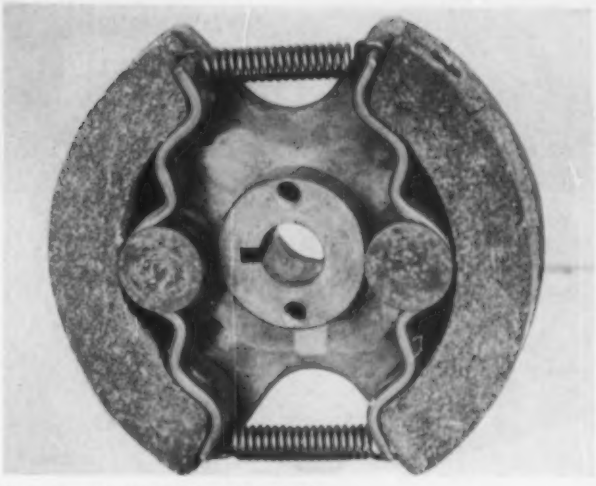
Circle 1, Reader Service Card



Miniature roller clutches . . .

permit drive in one direction and freewheeling in the opposite. Assembly consists of hardened and ground cam block, four hardened and ground bearing steel rollers, four springs and two side retainers. Available in four sizes from 0.1875-in. bore and 0.625-in. OD through 0.625-in. bore and 1.625-in. OD. Clutch dimensions range from 0.250-in. shaft with 0.8125-in. housing through 0.375-in. shaft with 1.3125-in. housing. Right- or left-hand drives are offered. Clutches are said to meet requirements of designs involving near-zero backlash, freewheeling, selective coupling, automatic cycling, dual or multiple drives and infinitely adjustable ratchets. About $1.40 in production quantities. Small quantities from stock. **Miniclutch Co, 373 Morse St, Hamden, Conn.**

Circle 2, Reader Service Card



Cam-type centrifugal clutch . . .

uses moderate camming or locking-in action that permits it to disengage at approximately same speed at which it engages, with or without load. Designed for applications that have high operating speeds or medium pulsating loads. Affords quick release where necessary and is suitable for applications where gradual engagement is required or in operations starting with high inertia. In motor applications, clutch provides low line voltage protection since necessary starting current is reduced. Available in 1 to 30 ft-lb capacities, with speeds of 1200 to 3600 rpm, 4¼-in. OD, $\frac{7}{16}$ to 1-in. dia bore. Can be adapted to pulley, sprocket, gear or coupling drives mounted on driving or driven member. Price and delivery data not made available. **Fairbanks, Morse & Co, Beloit, Wis.**

Circle 3, Reader Service Card

High-speed power-drive flexible shaft . . .

transmits power at speeds two or three times max recommended for standard ball bearing flexible shaft. Rubber-covered power drive shaft has tight-wound precision flexible shaft core and ball bearings at each end. Couplings on each end are bored to fit application. Available with $\frac{3}{8}$, $\frac{1}{2}$, or $\frac{3}{8}$-in. flexible shaft core. Max recommended speeds are 6900 rpm for first two models, 5750 rpm for $\frac{3}{8}$-in. model. Prices for 6-ft shafts are $35, $43.70 and $56, respectively. Delivery, 1 wk. **Stow Mfg Co, 426 Shear St, Binghamton, NY.**

Circle 4, Reader Service Card

Solution-level control . . .

also automatically maintains chemical concentration. Feeds dry chemicals into water, mixing them as they are introduced to main tank. Solution strength is said to be accurately variable. Hopper size can be made adequate for a work shift, a day or a week. Solution-level control only, about $195. Delivery, from stock to 2 wk. **Cincinnati Cleaning & Finishing Machinery Co, 2074 Hageman St, Cincinnati, 41.**

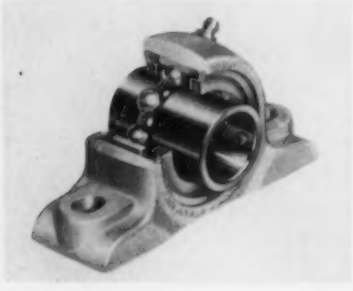
Circle 5, Reader Service Card

. . . CONTINUED ON PAGE 96

Low-nickel stainless . . .

steel for 900 to 1600 F remains austenitic in all conditions. At room temperature, it exhibits a controlled hardness between 300 and 550 Brinell, depending on processing. This material, with a room temperature hardness of 344 Brinell, exhibited a hot hardness of 250 Brinell at 1100 F after 1000 hr. Said to be nonmagnetic. May be machined, cut, forged and welded. Available as forging billets and rounds from ⅜ to 3 in. inclusive. **Armco Steel Corp, Middletown, Ohio.**

Circle 6, Reader Service Card



Pillow block bearings . . .

with ductile die-cast housings that resist shock and vibration are said to meet the need for low-cost units to carry light loads at normal speeds. Bearings are made with extended inner ring, two setscrews for locking bearing to shaft, and elongated bolt holes for mounting. Construction compensates for normal shaft misalignment. Factory-lubricated units are available in shaft sizes from ½ through 1 7/8 in. Companion flange bearings with ductile housings are also available. Design includes eccentric collar-type shaft lock and automatic self-alignment. **Hoover Ball and Bearing Co, 5400 S State Rd, Ann Arbor, Mich.**

Circle 7, Reader Service Card

Instant speed changers . . .

in horizontal and vertical units obtain stepless speed changes by rotating an external hand wheel that is directly connected to mechanically adjusted driver sheave, increasing or decreasing pitch diameter. Driven sheave is spring-loaded and automatically changes pitch diameter; as driver sheave is increased in pitch diameter, driven-sheave diameter decreases and vice versa. Four-position motor mounting and two-position gear mounting adapts unit to varying space condition. Four case sizes are contemplated in complete line with a max speed ratio of 10:1 in the 1, 1½, 2 and 3-hp units and 4:1 in the 40, 50 and 60-hp units. Max ratio of intermediate units is 6:1. Each of the units can be assembled to provide intermediate ratios of 5:1, 4:1, 3:1 and 2:1, using 1800 or 1200-rpm standard squirrel-cage or synchronous induction motor. Remote control equipment can be handled by using electrical pneumatic or hydraulic pilot systems. **Allis-Chalmers Mfg Co, Milwaukee 1.**

Circle 8, Reader Service Card

Miniature brake-clutch . . .

is designed for close-coupled applications where high performance, fast response, reliability and low inertia are desired. Min torque, clutch or brake is 6 in.-oz; will not drop a load below 2.5 in.-oz min while switching from brake to clutch. Power consumption is 4.5 w. Response is 8 millisec. Pancake units have impregnated and encapsulated coils, zero backlash, no slip-ring requirement, zero endplay. Unit is 0.500 in. long from servo flange to end of cap. Servo mounting is 1 in. dia. **Autotronics Inc, Box 208, Florissant, Mo.**

Circle 9, Reader Service Card

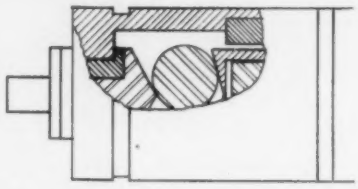
Tape as thin as 1 mil . . .

can be skived from cylinders of a new grade of TFG-fluorocarbon resin now being produced in commercial quantities. Also available as molding and extrusion powder, granulated to ultrafine particle size to provide lower preform pressures and uniform density throughout complex parts. Volume quantity price of $5 per lb for 24,000 lb or more has been established. Materials offers same combination of physical, thermal, chemical and electrical properties characteristic of all Teflon resins. **E I du Pont de Nemours & Co, Washington Works, Parkersburg, W Va.**

Circle 10, Reader Service Card

Miniature inertia switch . . .

in SPDT or SP3T arrangements is actuated by acceleration, deceleration, impact, and/or shock. Acceleration sensitivity can be adjusted from less than 1 to over 100 g with accuracy of 1%. Momentary, latching with mechanical or electrical reset or latching with negative g reset contact arrangements are offered. In all contact arrangements, except electrical reset, no electrical power is required. Constant performance is maintained over −65 to 250 F. Choice of unidirectional, bidirectional or omnidirectional in any one plane is available. Response time is said to be less than 1 millisec. Weighs 1.75 oz. Standard length is 1.698 in. x ⅜ in. dia. Guaranteed for 10,000 reliable cycles of operation. **Inertia Switch, Div Safe Lighting Inc, 527 Lexington Ave, New York 17.**



Circle 11, Reader Service Card

Magnetic counter . . .

can be manually set to count from 1 to 899. Subtractive counter shows count remaining at all times. Normally closed SPST contacts open on next pulse after counter zeros. Contact rating is 2 amp resistive. Operates on 6, 12, 24 or 110 v dc in a temperature range of −65 to 250 F. Power consumption is 3½ w. Size is 1⅛ x 1 7/16 x 2 in. without panel mount case. Weighs 3 oz. **Abrams Instrument Corp, 606 E. Shiawassee St, Lansing 1, Mich.**

Circle 12, Reader Service Card

Locknut for up to 1200 F . . .

is lightweight and offers min tensile strength of 200,000 psi at room temperature; over 150,000 psi at 1200 F. Avail-

. . . CONTINUED ON PAGE 98

ANALYSIS — Kaydon studies every pertinent bearing requirement, such as speed, load, safety, operating and fatigue life factors.

DESIGN — Kaydon engineers bring an unequalled fund of knowledge and bearing design experience to your project.

MANUFACTURING AND TESTING — Complete, modern fabricating facilities . . . precision control of all quality factors.

custom engineering

KAYDON custom bearing designers can prove or improve your product

Why penalize product performance success with "make-do" bearings? Kaydon's long experience points out that standard bearings often *won't do,* aren't always efficient or economical.

Kaydon engineers creatively design, develop and manufacture special, modified, and standard ball and roller bearings. All-new Kaydon "idea bearings" or modified types will help you *prove* your new product designs; *improve* your redesigns. Kaydon can incorporate millionth's-of-an-inch precision, light weight or super-rugged construction to exactly match the bearing to your application.

Send us sketches or scale prints of your bearing problem. *There's no obligation.*

Typical Kaydon-developed special bearings

World's largest precision ball bearing (165") designed and built by Kaydon, rotates radar antennae.

World's thinnest radial ball bearing — Kaydon "Reali-Slim," 12.00" I.D., 12.500" O.D., .250" thick.

World's newest Thin-Shell Needle Bearing — for automotive and industrial use.

World's lightest large aircraft wheel bearings 9/16" cross section.

THE KAYDON ENGINEERING CORP.

MUSKEGON, MICHIGAN

All types of ball and roller bearings — 4" inside diameter to 178" outside diameter . . . Taper Roller *Roller Thrust *Roller Radial *Needle Roller *Ball Radial *Ball Thrust Bearings.

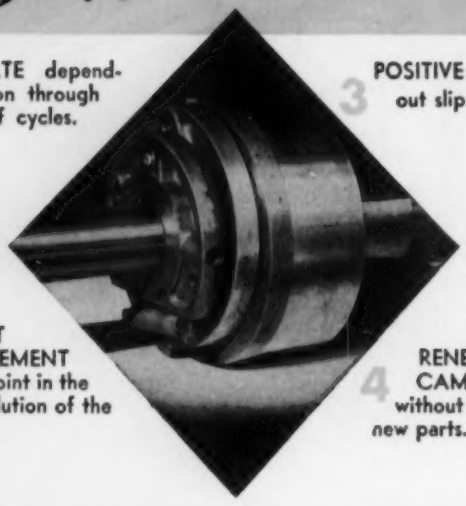
K-581

HILLIARD CLUTCHES FOR POWER CONTROL DESIGNS

HILLIARD
Single Revolution CLUTCH

1 ACCURATE dependable action through millions of cycles.

3 POSITIVE motion without slip or lag.



2 INSTANT ENGAGEMENT at any point in the the revolution of the driver.

4 RENEWABLE CAM SURFACES without machining or new parts.

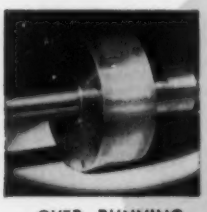
The Hilliard Single Revolution Clutch *is automation* because it provides precise accurate intermittent motion automatically. Control can be electrical or mechanical.

The use of Hilliard Single Revolution Clutches has improved the operation of tube straightening and cut-off machines—shears—conveyors—riveting and fastening units—case loaders—bottle unscramblers—weighing and packaging—indexing and feeding—marking—punching—textile and business machines—radar apparatus—proportionate pumps—and many other types of mechanisms.

WRITE TODAY FOR BULLETIN 239 WITH COMPLETE INFORMATION.

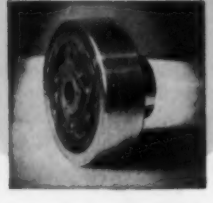
• OTHER HILLIARD CLUTCHES •

CONSIDER AUTOMATION - INVESTIGATE THESE PRODUCTS



HILLIARD - TWIFLEX CENTRIFUGAL COUPLING for smooth, easy starting of any load automatically with overload protection and ability to accommodate shaft misalignment. Ask for Bulletin CE-3.

OVER-RUNNING CLUTCHES for automatic instantaneous engagement and release on two speed drives, dual drives and ratchet or backstop action. Ask for Bulletin 231.



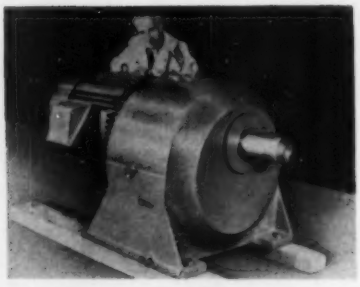
SLIP CLUTCHES for overload protection, or constant torque and to provide constant tension and permit speed variation on rewind stands. Ask for Bulletin 300.

THE HILLIARD CORPORATION
MANUFACTURING CLUTCHES FOR OVER 50 YEARS
101 W. Fourth St. Elmira, N. Y.

IN CANADA: UPTON • BRADEEN • JAMES, LTD.

able in four sizes, including 10-32 through ¼-24, locknuts are said to be as much as 57% lighter than conventional 1200-F standard. Tests are said to indicate unit retains lock for more than 15 applications after a 50-hr soak at 1200 F in stressed condition. Also show a stress rupture life in excess of 23 hr at 1200 F at a stress of 100,000 psi. List price for the 10-32 is $91.60 per 100. **Standard Pressed Steel Co, Jenkintown, Penna.**

Circle 13, Reader Service Card



Gearmotors to 200 hp . . .

are standard and feature high efficiencies of 94 to 97% depending upon number of reductions. Double, triple and quadruple reductions are offered in AGMA ratios ranging up to 440:1. Final stage helical gearing is carburized and hardened and gear teeth are precision ground. Large-diameter shafting and oversize bearings are said to be capable of handling most severe overhung loads and shock conditions. Gears, shafting and bearings meet AGMA standards. Standard NEMA D flanged and foot-mounted motors are available in sizes J and H. Most standard ac motors can be furnished from stock. **Philadelphia Gear Corp, 3620 G St, Philadelphia 34.**

Circle 14, Reader Service Card

Gearbox design service . . .

covers development and manufacture of all types and sizes, from "scratch" or from specifications. Will also quote on producing an order in accordance with customer's prints. **E B Sewall Mfg Co, 705 Raymond Ave, St Paul 14.**

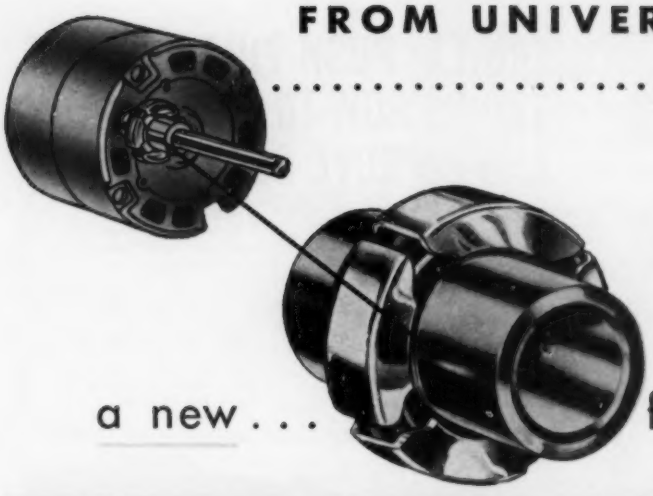
Circle 15, Reader Service Card

Interchangeable packings . . .

make ball-bearing swivel joints suitable for services ranging from chemicals at temperatures between —40 and 400 F at 300-psi internal pressure to handling of steam and hot gas at 440 F max at 360 psi. Max temperature rating is 600 F at 200 psi for occasional swing or oscillating service. Cold working pressure is 1000 psi. Joint design permits replacement of molded elastomer or disk packing seals without removal of

(Continued on page 101)

FROM UNIVERSAL ELECTRIC



THE UNIVERSAL BEARING*

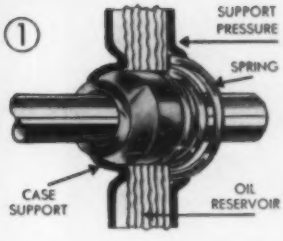
a new . . . free aligning bearing

*PATENT APPLIED FOR

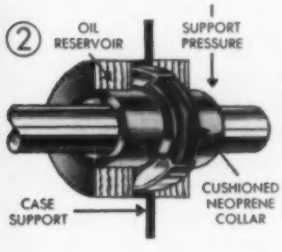
A new revolutionary bearing assembly, the **Universal Bearing**, that promises to eliminate fractional hp motor bearing problems has been designed and is now a feature of UNIVERSAL ELECTRIC motors. The new **Universal Bearing** does not rely on spring tension to aid its alignment but utilizes only the shaft itself. This is accomplished by moving the axis of support from the end of the bearing to the center . . . the ideal location.

Flexibility and rigidity of bearing support and bearing are of primary importance, particularly in fractional hp motors. The design of the **Universal Bearing** insures continuous and positive alignment to the shaft at all times. A neoprene collar, which is flexible, provides a perfect and firm fit between bearing and bearing support surface. The **Universal Bearing** is inherently in balance . . . and cannot get out of either alignment or balance. It is as firm as a rigid bearing; more flexible than a self aligning bearing.

The **Universal Bearing** Assembly provides longer bearing life, better lubrication and an easier starting motor that runs without a whisper of sound. This is the first major bearing improvement since UNIVERSAL introduced the coil spring bearing retainer in 1944.



In the conventional bearing assembly, the case support places pressure on the end of the bearing rather than in the center. A spring is utilized to allow the bearing to accommodate shaft misalignment. The spring, however, does not provide even tension around the end surface of the bearing on all loads. When at rest, the weight of the shaft pulls the bearing out of line and the spring, because of uneven tension, tends to *resist* rather than help the bearing to adjust; actually holds the bearing in misalignment. This results in a bearing not perfectly aligned with the shaft on all loads and causes wear on shaft and bearing . . . sometimes actual seizure and motor failure. At the very least, this condition results in a hard starting or a noisy motor.



The new **Universal Bearing** is so designed that support pressure is on the center of the bearing, rather than on the end. This eliminates the uneven tension common in the spring and permits adjustment of the axis position to *true* alignment. The bearing is inherently in balance and can adjust to any shaft misalignment 100% of the time under any load conditions. A neoprene collar is used around the outside surface of the bearing to accommodate manufacturing tolerances. Small metal clips are fitted around the outside surface to confine the neoprene collar and allow a free sliding movement along the bearing support surface. The neoprene collar expands or contracts within the metal clips to afford a perfect mating surface.

50

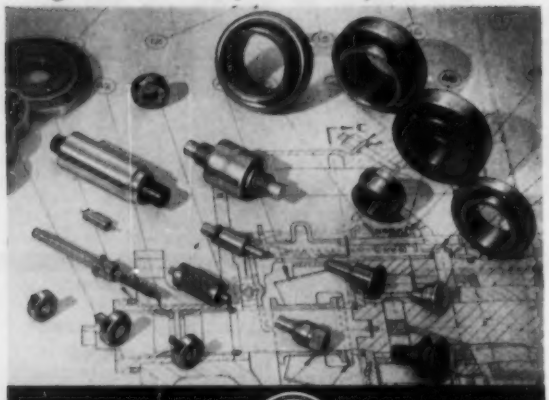
UNIVERSAL ELECTRIC COMPANY

PRECISION ELECTRIC MOTORS

EXECUTIVE AND GENERAL SALES OFFICES: OWOSSO, MICHIGAN, DEPT. 12

BEARING **ideas**

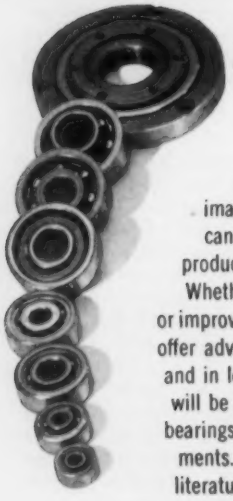
for design engineers



VERS-O-LINE

bearings by Hartford

ENGINEERED TO BE PART OF YOUR PRODUCT



Types

- Radial—H-Series
- Radial—Conrad Loaded
- Radial—Full Complement
- Thrust
- Versa-Twin—Twin Row

Vers-O-line bearings challenge the imagination. In many applications, they can be engineered so that parts of your product can form the inner or outer races. Whether you are designing a new product or improving an old one, Hartford Vers-O-lines offer advantages in performance, unitization and in low cost. Hartford bearing engineers will be glad to adapt or design Vers-O-line bearings to meet your exact product requirements. Write for comprehensive technical literature. Contains standard Vers-O-lines, case history applications, and bearing ideas that can be helpful to you.

Hartford

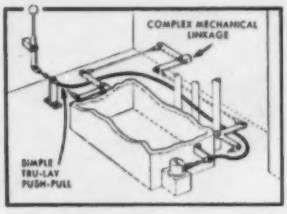
PRECISION BALLS • BEARINGS

HARTFORD STEEL BALL CO., INC.

43 Jefferson Avenue, West Hartford 6, Conn.

CIRCLE 153 READER SERVICE CARD

TRU-LAY PUSH-PULL DATA FILE SHOWS HOW TO SIMPLIFY AND IMPROVE DESIGN



Push-Pull remote controls, shown here, are flexible, have but one moving part, and give a lifetime of accuracy. Mechanical linkages are complex, are made of many parts, wear at many points, and produce increased backlash, lost accuracy, and vibration rattles.

This Push-Pull Data File—containing 7 engineering bulletins—will show you how these flexible controls have eliminated mechanical linkages on hundreds of products. You can make *your* products more useful, easier to sell, with Push-Pull controls. Write for your Data File today.

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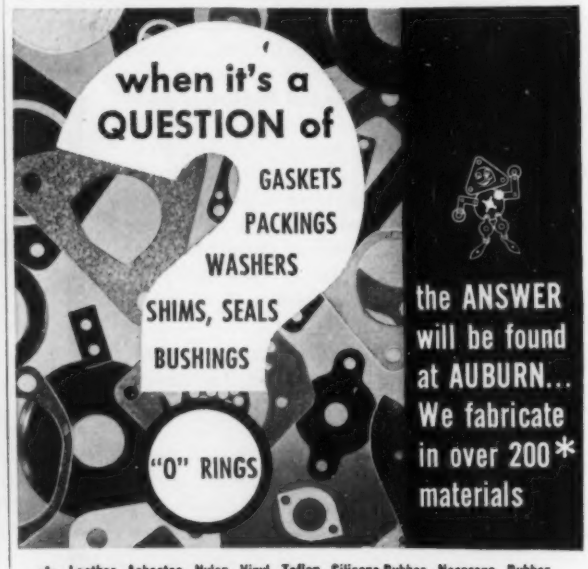


* Leather · Asbestos · Nylon · Vinyl · Teflon · Silicone Rubber · Neoprene · Rubber · Cork · Fibre · Compositions · Phenolics · Cloth · Felt · Paper · Cardboard · Plastics · Brass · Steel · Copper · Aluminum · Kel-F · Vitron A · Mylar · Other Special Materials

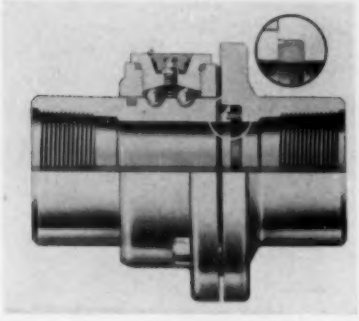
Send specifications or blueprints for prompt quotations and recommendations. No obligation.

THE AUBURN MANUFACTURING CO.

306 Stack St., Middletown, Conn.

New York, N. Y.; Rochester, N. Y.; Detroit, Mich.; Chicago, Ill.; Minneapolis, Minn.; Pittsburgh, Pa.; Cincinnati, Ohio; Ridgewood, N. J.; Atlanta, Ga.; Memphis, Tenn.; St. Louis, Mo.; Washington, D. C.

CIRCLE 155 READER SERVICE CARD



joint from line. Available in ⅜ through 4-in. sizes in six basic swivel joint configurations, providing 360° rotation in one, two or three planes. Joint metal is 1040 steel. **Chiksan Co, Brea, Calif.**

Circle 16, Reader Service Card

Time-delay mercury switch . . .

permits delay periods of 1 to 30 sec, factory set, accurate to within 5% of total time. Time delay is said to be constant for life of switch and is not influenced by temperature variations. Can be recycled constantly without cooling-off periods. Supplied with ratings up to and including 30 amp at 250 v. Normally closed, delayed break, instant remake and normally open, delayed make, instant break models are offered. Unit is 3 x 1⅜ in. and weighs 1.5 oz. **American Designed Components Inc, Jericho, NY.**

Circle 17, Reader Service Card

High-tensile cap screws . . .

and nuts are said to have a proved tensile strength of 186,820 psi, exceeding CAA bolt tensile strength requirements. Cap screw head design is said to be 20% higher than SAE specifications, matching increased bolt strength and eliminating head damage caused by wrench slippage. Line is produced from special alloy steel that has been double-heat-treated. **Bowman Products Co, Cleveland, Ohio.**

Circle 18, Reader Service Card

Hydrostatic transmissions . . .

rated up to about 9 hp where constant output speed is required and to 18 hp or higher, depending on speed ranges, for variable output speed have been designed particularly for mobile equipment. Single lever on 4-way control valve controls forward and reverse speed. System features an automatic overload protection. Two of the following four basic variables are part of the hydrostatic system: fixed displacement pump, variable displacement pump, fixed displacement motor or variable displacement motor. Elements may be

(Continued on page 104)

COMPLETE LINE OF
ACME ROLLER CHAINS
and ACCESSORIES
Available at YOUR LOCAL
INDUSTRIAL DISTRIBUTOR

Acme Chains are available nationally through reliable Authorized Distributors.

It is the basic policy of Acme Chain to sell its product through *Authorized* Distributors who have entered an agreement with the company to stock merchandise and service all Acme Products.

The quality of all Acme Products will continue to be — as it has been since the founding of the company — the highest quality that experience, materials, design, craftsmanship and facilities can produce.

Acme supports their Distributors with all the knowledge and assistance of their Engineering Department in an advisory and technical capacity.

Order Acme Chain from your Industrial Distributor with implicit confidence that you will receive prompt and efficient service at all times.

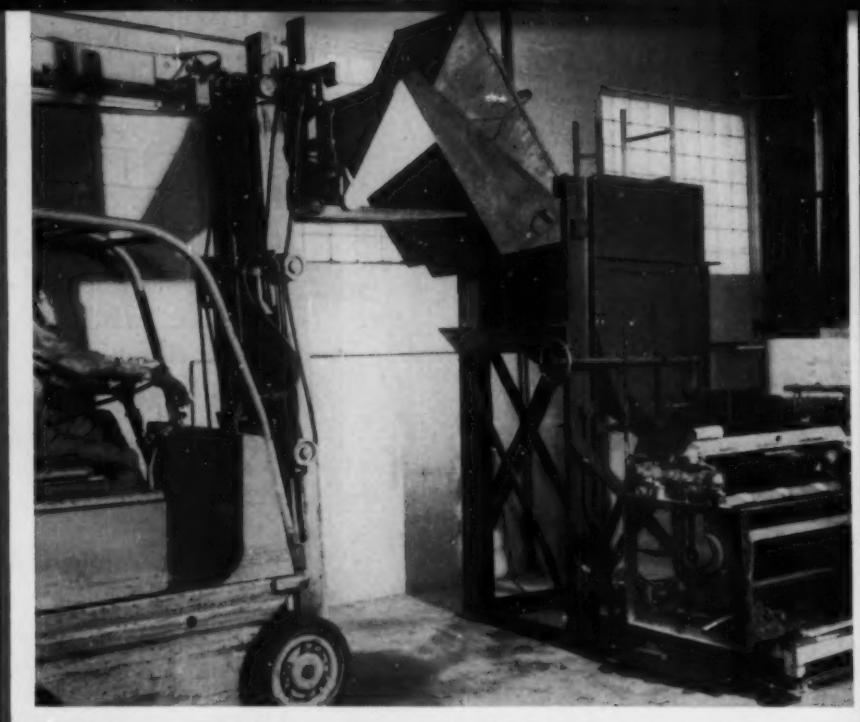
Write Dept. 1-B for new 100-page illustrated catalog, including new engineering section showing 36 methods of chain adjustments.

Call ***ACME*** for Service

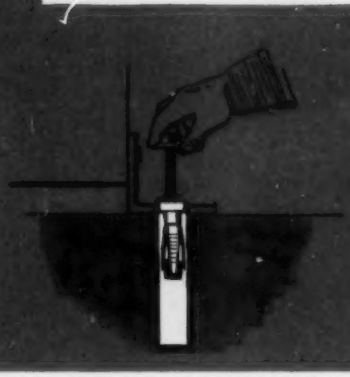
Acme Chain Corporation
HOLYOKE
MASSACHUSETTS

COMPLETE LINE OF ROLLER CHAINS AND SPROCKETS • DOUBLE PITCH CONVEYOR CHAINS • STAINLESS STEEL CHAINS • CABLE CHAINS • FLEXIBLE COUPLINGS • STANDARD AND SPECIAL ATTACHMENTS

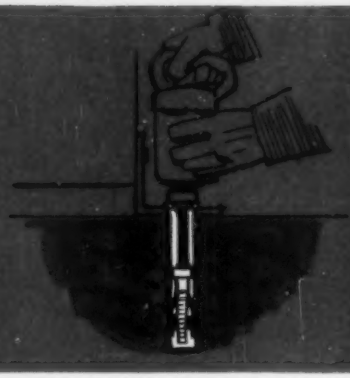
Shown above is a Bethlehem Square Head Anchor Bolt, with malleable-iron shell, forged-steel plug, and hardened washer.



Determine position of machine; mark holes on floor; drill holes in machine legs to required diameter; drill holes in floor to required diameter and depth.



Move machine into position; insert assembly through hole in machine leg into the hole drilled in the concrete floor.



Tighten bolt head with power wrench. This draws up the plug, expanding the serrated leaves of the shell. Machine is locked tightly to the concrete base.

Special bolts that anchor machinery

When the forklift truck dumps its load, that hopper bin really vibrates. Keeping it anchored firmly in place used to be quite a problem.

Then Bethlehem fasteners engineers were called in: They recommended using a special-headed anchor bolt with an expansion shell to anchor the hoppers. As shown in the drawings above, this bolt *locks* machinery to base concrete. Today, these hopper bins are firmly anchored, undisturbed by the drastic vibration.

Our fasteners engineers are often able to find a solution that adds up to a saving for the user. If you'd like their help, just get in touch with our nearest sales office.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

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BETHLEHEM STEEL

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CIRCLE 157 READER SERVICE CARD

BLOOD BROTHERS

Universal Joints

OFFERED BY ROCKWELL-STANDARD IN SIZES FOR ALMOST ANY PRODUCT APPLICATION

SAVE ENGINEERING TIME!

Here at Rockwell-Standard, you can select from a wide, wide range of Blood Brothers Universal Joints and complete drive assemblies. Torque capacities range from 350 to 500,000 inch-lbs.—lengths from very close-coupled industrial joints to assemblies 120 inches overall.

You can be confident they are produced in a modern, centrally located plant, tooled for precision manufacturing. And you can rely on their high reputation for dependability.

When you need universal joints and drive lines, you can save valuable engineering time too—by stating your problem to our engineers. They're cooperative, friendly and experienced. *Just write or call.*

WRITE FOR BULLETIN 557

and for your convenience in specifying, request our free Blank Form "Specification Sheets".

ROCKWELL-STANDARD CORPORATION

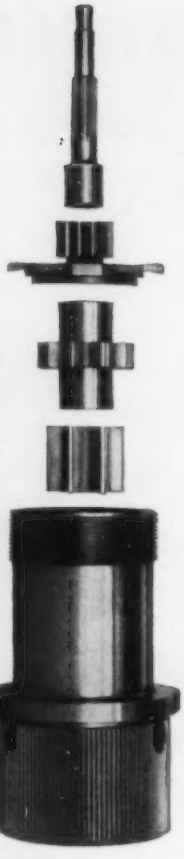
Blood Brothers Universal Joints

ALLEGAN, MICHIGAN

UNIVERSAL JOINTS
AND DRIVE LINE
ASSEMBLIES

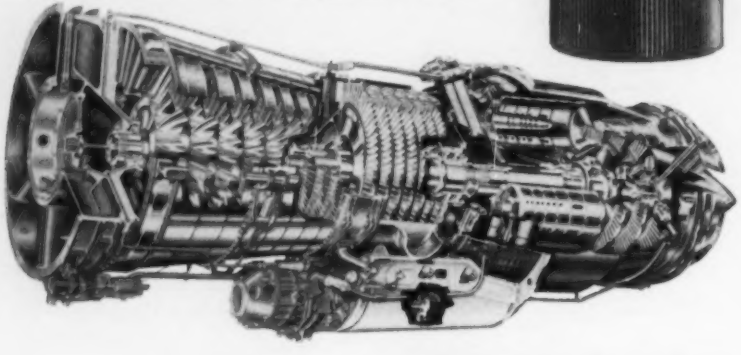
CIRCLE 158 READER SERVICE CARD

PRECISION for top-flight performance!



Rigid PRATT & WHITNEY AIRCRAFT precision requirements spell *performance* . . . top-flight performance. Reason: The future is at stake. And that future can well ride on gear teeth. Since 1940, PRATT & WHITNEY AIRCRAFT gear tolerances have been *Perkins'* standards . . . for commercial gears as well as aircraft. Such precision pays off in longer wear, greater efficiency, lower maintenance cost. That type of precision can pay off for you, too.

Famous PRATT & WHITNEY AIRCRAFT J57 Jet Engine, power plant for Air Force "Snark" guided missile, is geared for both commercial and military performance by *Perkins*. Typical tolerances on *Perkins* gears: .0004 tooth to tooth; .0015 cumulative; .0005 on involute. On spline: .0006 tooth to tooth; .0008 cumulative; .0005 on involute. Most *Perkins* gears are carburized, hardened and ground.



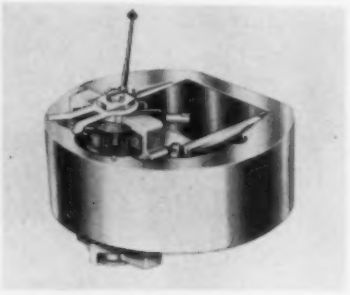
YOURS ON REQUEST Folder showing custom gears Perkins has made (from various materials) for aircraft, automotive, precision instruments, home appliances, portable and machine tools, and other products. Includes Perkins facilities for producing various gear types and sizes. *Write today.*

PERKINS
MACHINE AND GEAR CO.

Dept. 62 West Springfield, Mass.
Telephone: REpublic 7-4751

used in any of the four possible combinations of pump and motor, depending upon end use. Constant speed drives are furnished in 2, 3, 4, 6, 8 and 9 -hp sizes. **Sundstrand Hydraulic Div, Sundstrand Machine Tool Co, Rockford, Ill.**

Circle 19, Reader Service Card



Instrument movement . . .

has closed ring that serves as one pole of the magnetic system and an Alnico bar magnet that is mounted so that one pole terminates in ring and opposite polarity terminates in pole piece. Alnico magnet is mounted external to moving coil, eliminating any restriction on magnet size. Barring design is said to provide max flux density in working gap. Newly offered in all dc panel meter and portable sizes. **Triplett Electrical Instrument Co, Bluffton, Ohio.**

Circle 20, Reader Service Card

Pressure transmitter . . .

has differential sensitivity of one part in 1000 or better, 0.2% measurement accuracy, infinite resolution, and zero output that may be preset at any point throughout range. Shock-resistant transmitter is said to be suitable for corrosive atmospheres. Available in static pressure ranges from 0 to 100 to 0 to 3000 psi with differentials up to 100% of range; 6.3 or 110-v ac inputs and full-scale outputs of 50 mv dc or 5 v ac or dc are available. Sensing element is a differential transformer with built-in demodulator for dc outputs. **International Resistance Co, Computer Components Div, 401 N Broad St, Philadelphia 8.**

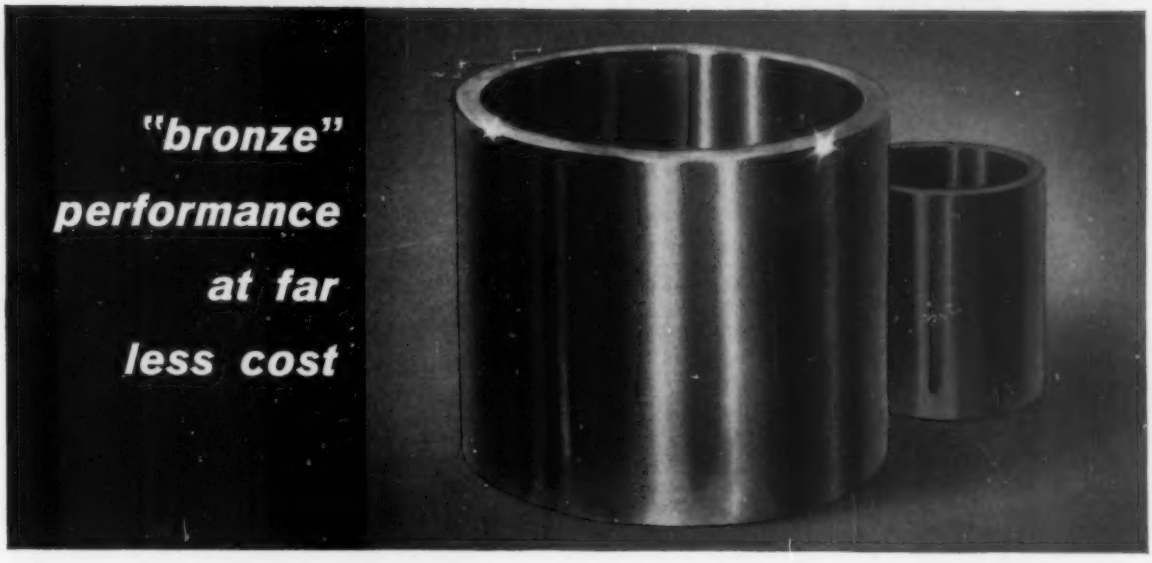
Circle 21, Reader Service Card

20-in. variable scale . . .

is a manual device for reading such records as oscillograms or telemeter data and for use in data reduction. A triangular spring with 100 calibrated coils is heart of the instrument. An auxiliary number spring expands and contracts with it and facilitates reading of triangular spring coils. Spring itself is used directly in linear computations. **Gerber Scientific Instrument Co, 89 Spruce St, Hartford 1, Conn.**

Circle 22, Reader Service Card

introducing NEW IRON OILITE 212 BEARINGS



The important difference between the porous bronze bearing (right) and the all-new Iron OILITE* 212 Bearing (left) is cost. While both bearings give long, maintenance-free service, Iron Oilite 212 bearings now open the door to major savings for many equipment manufacturers.

Performance-proved in life tests and on actual products, Iron Oilite 212 bearings have a service life equal to porous bronze when used for products where corrosion is not a problem and mechanical strength requirements are within tolerable limits.

A high oil content — approximately 20% by volume — assures adequate lubrication for the lifetime of many end products. In addition, a unique built-in service factor gives Iron Oilite 212 bearings extraordinary protection against temporary overloads. They perform best when carrying medium to heavy loads at relatively low speeds and readily equal the performance of bronze at the high speeds required by home appliances, fractional horsepower motors, power tools, light machinery and other products.

It's another Amplex first . . . a typical example of how Amplex serves a growing number of original equipment manufacturers with "better quality at lowest cost". Use Amplex's extensive research and engineering facilities to your own advantage. Savings can be impressive if you require bearings in volume.

free sample

of **IRON OILITE 212** Bearing 1" ID x 1¼" OD x 1" Length and full information on request. Consult the Oilite engineer in your area. Find him in the Yellow Pages under "bearings" or write direct to Amplex. Address Dept. A-1

COMPARISON OF TYPICAL PHYSICAL PROPERTIES

	Iron Oilite 212	Oilite Bronze
Porosity, % oil by volume	18 - 23	18 - 23
Ultimate Tensile Strength, (psi)	10,000	18,000
Compressive Yield Point, (psi)	9,500	20,000
Rockwell Hardness	RH - 35	RE - 65
Specific Gravity	6.1 - 6.5	6.4 - 6.7

* REGISTERED TRADEMARK
ONLY CHRYSLER MAKES OILITE

SINCE 1929 — A CHRYSLER OILITE PRODUCT

the most trusted name in powder metallurgy!

AMPLEX DIVISION

CHRYSLER CORPORATION, DETROIT 31, MICHIGAN

SELF-LUBRICATING BEARINGS • PRECISION PARTS • METAL FILTERS • FRICTION UNITS

News about COATINGS FOR METALS

from Metal & Thermit Corporation

How to match chromium plate to design requirements

No longer is all chromium plate alike physically despite the fact that it remains the same *chemically*.

FOR MORE CORROSION RESISTANT BRIGHTWORK

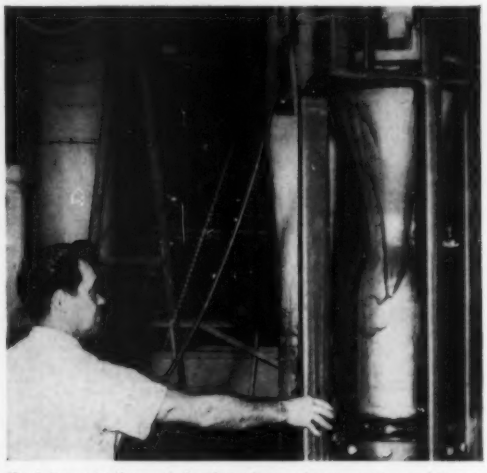
The newest type of bright chromium plate offers much greater corrosion resistance than previously obtainable. It is free from the microscopic cracks inherent in ordinary chromium deposits and thereby prevents corrosives from contacting the underlying metal. For this reason, Unichrome *Bright* Crack-Free Chromium makes a major improvement in the corrosion resistance of decorative brightwork. It assures more uniform plate distribution and ample thicknesses in recesses. And with freedom from the cracks characteristic of ordinary chromium, Bright Crack-Free Chromium actually *reinforces* the resistance of the copper and nickel undercoats normally used.

Bright Crack-Free Chromium promises to put an end to pitted and rusted auto brightwork. It plates without cracking, and eliminates pores by producing thicker bright deposits free from cracks. (Compared with ordinary chromium after 72-hour acetic acid salt spray test.)

TO OVERCOME CORROSION, WEAR, HEAT

Another new type of plate, Unichrome *Industrial* Crack-Free Chromium, delivers greatly improved corrosion, wear, and heat resistance for industrial or engineering-type applications. A ductile matte deposit free from corrosion-admitting cracks, it has excellent resistance to impact, abrasion, and thermal shock. Hardness ranges from 500 to 700 Knoop.

These properties of Unichrome Industrial Crack-Free Chromium are used to protect rocket engine assemblies subjected to hot, erosive, corrosive combustion gases. They also solve corrosion and wear problems on parts such as hydraulic rams, power steering shafts, high temperature molds, and washing machine shafts.



Resistance to thermal shock and superior corrosion resistance suit Unichrome Industrial Crack-Free Chromium for such uses as plating of rocket engine combustion chambers.

FOR OTHER APPLICATIONS

A third process, Unichrome SRHS® Chromium, has proved uniquely successful in applications where freedom from cracks is not required. It plates up to 80% faster than the ordinary chromium process, deposits chromium with less dulling and burning due to its unusually wide bright plate range. Its unique production advantages lead to an engineering benefit: more uniform control of plating quality.

NOTE: SRHS Chromium excels for plating stainless steel, enabling designers to "color-match" all brightwork on a product.

Send for bulletins giving more details. Write Metal & Thermit Corp., Rahway, N. J.

METAL & THERMIT
CORPORATION

The PERFORMANCE is in the DESIGN

Norgren Pressure Regulators

for air and non-corrosive gases

- Improve equipment performance
- Reduce compressed air costs
- Cut maintenance costs

Norgren Pressure Regulators: 1. Reduce line pressure to the desired working pressure; 2. Provide the most efficient operation of connected equipment; 3. Maintain the established pressure even with widely fluctuating line pressure and rapidly varying flow.—***Results:*** Better equipment performance. Longer equipment life. Lower maintenance and compressed air costs.

Highly Accurate Pressure Regulation over a wide operating range. Outstanding performance is the result of these design features: 1. Balanced valve; 2. Large effective diaphragm area; 3. Improved baffle and siphon tube; 4. Large passages; 5. Large valve openings.

Also Norgren regulators for water, oil, other liquids and steam.

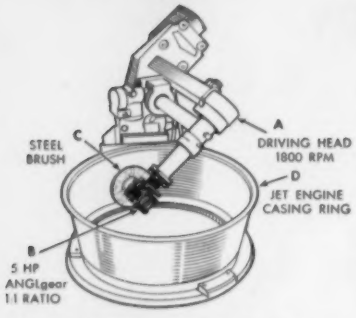
For complete information, call your nearby Norgren Representative listed in your telephone directory—or WRITE FACTORY FOR DESCRIPTIVE LITERATURE.

If it's Norgren...It's Dependable.

C. A. NORGREN CO.

3428 SO. ELATI STREET • ENGLEWOOD, COLORADO

ANGLgear® simplifies power-brush drive

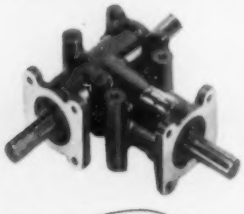


Drawing shows ANGLgear application on Osborn Brushamatic® unit developed for finishing jet engine case components. ANGLgear permits compact design, has capacity to withstand reversal every 20 sec. without overheating.

Osborn Manufacturing Co., Cleveland, Ohio, producer of power-brush finishing machinery, has found ANGLgear ideal for adapting brushing heads to right-angle drive. Offering high capacity for its size, ANGLgear permits compact head design, facilitates brushing in restricted spaces. At the same time, its light weight cuts the overhung load to a minimum, helping reduce bearing wear. And it has the stamina to meet operating conditions that include reversal every 20 seconds —without overheating or undue wear.

Perhaps ANGLgear can solve a similar 90° drive problem for you. Completely enclosed, permanently lubricated, and featuring universal mounting, it is easily incorporated in your power transmission systems and requires little or no maintenance.

You can specify standard ANGLgear in ⅓, 1, 2¼ and 5 hp ratings, with 1:1 or 2:1 gearing and 2 or 3-way shafting. See data in Sweet's Product Design File or contact our local distributor.



AIRBORNE®

AIRBORNE ACCESSORIES CORPORATION
HILLSIDE 5, NEW JERSEY

CATALOGS and BULLETINS

To obtain copies of literature described below, circle corresponding number on postcard inside back cover. For those catalogs and bulletins available only when requested on company letterhead, see page 114.

STAINLESS STEEL PRODUCTS—Buyers' Guide, 159 pp. Lists approximately 3000 firms that make products of, or offer services pertaining to, stainless steel. Contains 188 specifications and general stainless product categories, followed by manufacturers' names and locations. Committee of Stainless Steel Producers, American Iron and Steel Institute, 150 E 42nd St, New York 17.

Circle 23, Reader Service Card

ELECTRIC FURNACE STEELS—Catalog, 48 pp. Details melting, rolling, finishing, thermal-treating and conditioning capacities. Illustrated with production photos. Also included is listing of steels available in standard and special analyses. Rolling limits and chemical analyses are also shown. Copperweld Steel Co, Aristoloy Steel Div, Warren, Ohio.

Circle 24, Reader Service Card

SAPPHIRE PRODUCTS—Manual 5, 26 pp. Contains general information on properties of industrial sapphires and availability; designates types, nomenclature and tolerances of five basic jewel bearing types; gives design data that includes graphs, formulas for calculating frictional losses, basic design factors and listings of stock sapphire V and ring jewel sizes. Gives information on jewel bearing assemblies and shows typical applications. Arele M Gatti Inc, 524 Tindall Ave, Trenton, NJ.

Circle 25, Reader Service Card

FANS & BLOWERS—1959 catalog, 36 pp. Packaged fans, blowers and accessory equipment used in conjunction with cooling of electronic or electrical apparatus. Shows cabinet cooling units with air deliveries from 100 to 1200 cfm. Prices, quantity discounts and terms included. McLean Engineering Laboratories, PO Box 228, Princeton, NJ.

Circle 26, Reader Service Card

DRIP-PROOF PANCAKE MOTOR—Bulletin 2150, 4 pp. Presents engineering information on flange-type motor. Cutaway shows how motor achieves shorter length. Gives ratings, design and application data. Louis Allis Co, Milwaukee 1.

Circle 27, Reader Service Card

COATED STEEL TUBING—Folder PO-5558, 6 pp. Describes properties and gives OD and gages recommended for typical products. Includes OD-gage-shape ranges and gage-decimal thickness conversion table. Armco Steel Corp, Middletown, Ohio.

Circle 28, Reader Service Card

POWER PACKAGES—Bulletin 307, 6 pp. Describes construction, operation, ratings of 1½ to 10-kw units. Gives dimensions. Safety Industries Inc, Electrical Div, PO Box 904, New Haven 4, Conn.

Circle 29, Reader Service Card

POTENTIOMETERS—Brochure, 6 pp. Covers mechanical and electrical properties, specifications and nonlinear functions. Technology Instrument Corp, 7229 Atoll Ave, North Hollywood, Calif.

Circle 30, Reader Service Card

HEXAGON NUTS—Condensed catalog, 8 pp. Basic engineering information and specifications. Includes line drawings and photos. National Machine Products Co, Utica, Mich.

Circle 31, Reader Service Card

PRECISION SWITCHES—Catalog 101d, 24 pp. Covers representative line of snap-action and mercury switches. Includes data on high-temperature, maintained contact, explosionproof, high capacity, proximity, oil-tight, environment-free and multicircuit types. With dimensions, electrical ratings, characteristics and application information. Micro Switch, Freeport, Ill.

Circle 32, Reader Service Card

CERAMIC DESIGN—Handbook, 16 pp. Describes mechanical, electrical and environmental characteristics of engineered ceramics. Contains information on advantages and disadvantages of various fabricating techniques. Special sections discuss applications, metallizing of ceramics, design of ceramic parts and utilization of standard extruded shapes. Centralab, 900 E Keefe Ave, Milwaukee 1.

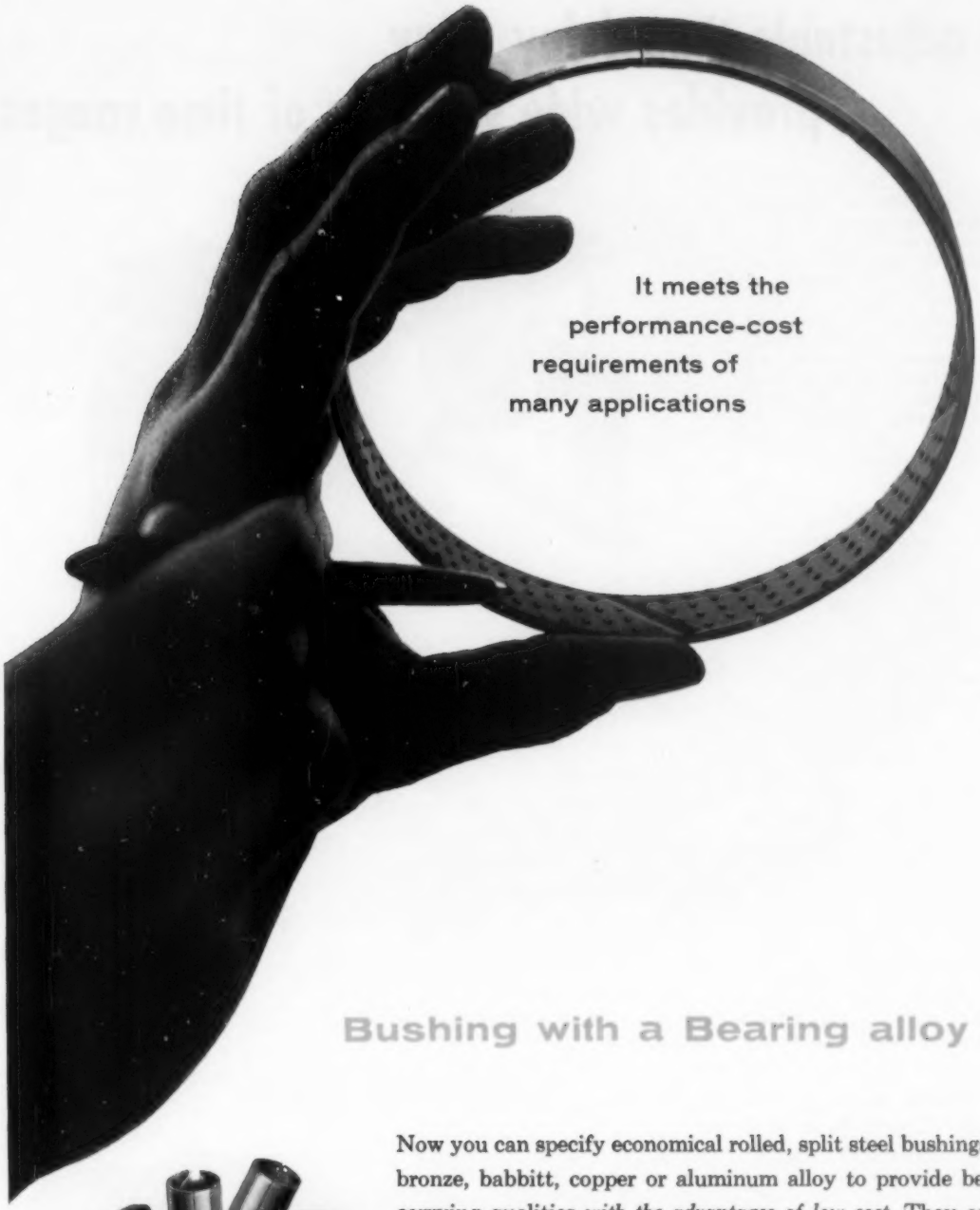
Circle 33, Reader Service Card

NICKEL-BASE ALLOY—Booklet F-30-128, 12 pp. Lists physical, chemical, mechanical properties and other data on corrosion-resistant Alloy F. Haynes Stellite Co, Kokomo, Ind.

Circle 34, Reader Service Card

PILOT-OPERATED RELIEF VALVES—Sheets 1.212a, 1.223a, 1.231a, 1.251b, 1 pp each. Covers construction, specifica-

(Continued on page 113)



Bushing with a Bearing alloy lining

Now you can specify economical rolled, split steel bushings lined with bronze, babbitt, copper or aluminum alloy to provide bearing load-carrying qualities *with the advantages of low cost.* They are available in many lengths and diameters, with straight, clinch, butt or special seams. They can be ball indented and have oil holes, grooves, notches, slots, as required. Quality controlled manufacturing to meet your specifications. We provide complete engineering service. A copy of the "Formed Bushing Design Guide" will be sent on request.

FEDERAL-MOGUL DIVISION

FEDERAL-MOGUL-BOWER BEARINGS, INC., 11043 SHOEMAKER, DETROIT 13, MICHIGAN

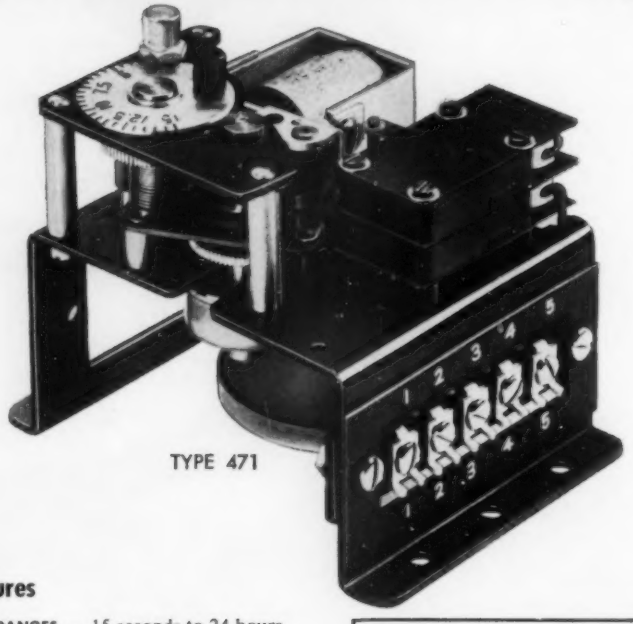
New adjustable time delay relay provides wide selection of time ranges

The new Cramer Type 471 Time Delay Relay provides an accurate, adjustable time delay between the operation of a control circuit and the subsequent closing or opening of one or two load circuits. Through selection of external wiring connections, the unit offers broad application flexibility and excellent accuracy at modest cost. Some typical uses include control of machine tools, batch processes, heat treating, automatic mixers, electronic devices, and signalling equipment of many kinds.

Operation

Type 471 is powered by a Cramer synchronous motor which drives precision-cut timing cams through a clutch, from a starting point set by a dial knob. The cams rotate at constant speed to a zero point, where the load switch is transferred. An instant later, a second cam opens the motor circuit. The clutch stays engaged, and the unit does not reset until the operator either opens the clutch circuit for the direct-clutch model, or closes the clutch circuit for the reverse-clutch model.

The direct-clutch unit resets automatically on power interruption, and repeats its complete cycle when power is restored. The reverse-clutch unit simply suspends operation and, when power returns, proceeds to complete the same time interval. Resetting is accomplished by a coil spring which drives the cam carriage back to a movable stop which is positioned by the dial knob. The stop location determines how quickly the cams will reach the switch actuation points, and so determines the timed interval.



TYPE 471

Features

TIME RANGES — 15 seconds to 24 hours.

ADJUSTMENT RANGE — 90% of full scale.

ACCURACY — within 2% of full scale.

RESET TIME — approx. ⅓ second or less.

LOAD SWITCHES — snap-acting SPDT, 10A 125V or 5A 250V AC, non-inductive.

MOTOR & CLUTCH — 115/220V, 25, 50 and 60 cycles. Reverse clutch optional.

GEARS — case-hardened steel, for life in excess of a million operations.

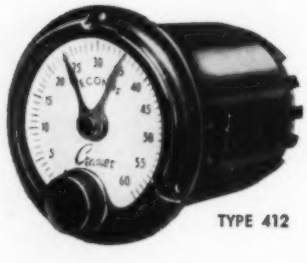
For details, write for your free copy of Bulletin PB-471.

TIME RANGES AND MINIMUM SETTINGS

TIME RANGE	DIAL DIVISIONS	MINIMUM SETTING
15 sec.	½ sec.	1.5 sec.
30 sec.	1 sec.	3 sec.
60 sec.	2 sec.	6 sec.
5 min.	10 sec.	30 sec.
15 min.	30 sec.	1.5 min.
30 min.	1 min.	3 min.
60 min.	2 min.	6 min.
2 hrs.	5 min.	12 min.
5 hrs.	15 min.	36 min.
12 hrs.	30 min.	1¼ hrs.
24 hrs.	1 hr.	2½ hrs.

FOR EXTREME ACCURACY PLUS WIDE SELECTION OF RANGES

Type 412 performs essentially the same functions as Type 471, except that it is designed for panel mounting, extreme accuracy, heavier loads, and 100% adjustability over the entire time range of each unit. Eleven full-scale time ranges are available, from 6 seconds to 24 hours. Overall accuracy is within plus or minus ½ of 1% of full scale, exclusive of setting errors. Repeat accuracy is within plus or minus ¼ of 1% of full scale on 30 second and longer ranges, and ½ of 1% of full scale on faster timers. The fully enclosed dial carries a red pointer to indicate the setting, a black pointer to indicate timing progress. The open blade SPDT load switch is rated 15A 125V, 10A 250V AC, and can handle inrush currents up to 40 amperes. A second load, operating within 1% of full-scale time following the first load, can be controlled from the motor switch itself. Internal SPST seal-in contacts permit operation from a 1/10-sec. control pulse if desired. Direct or reverse clutch operation is as described for Type 471.



TYPE 412

CRAMER CONTROLS
CORPORATION

Box 7, Centerbrook, Connecticut

There is no substitute for stainless steel
in automobiles

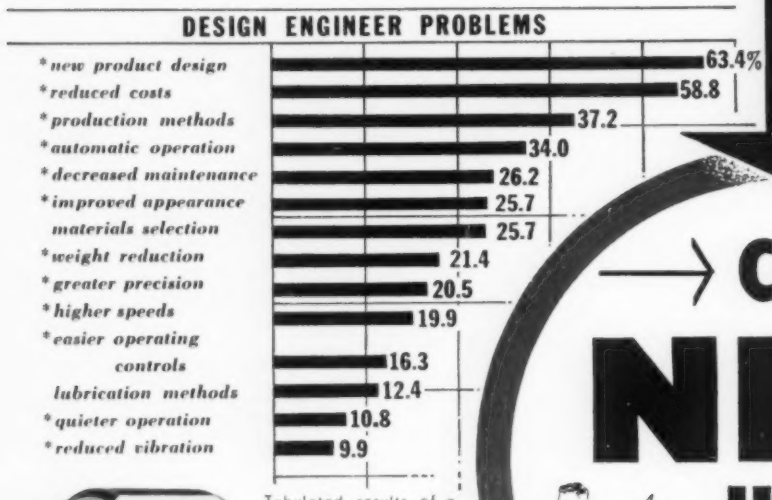
No other material is as bright, strong and resistant to rust and wear as Stainless Steel. It gives every car the clean, exciting beauty that sells in the showroom and re-sells on the used car lot. Look for *Stainless Steel* on your new automobile.

Specify McLouth high quality sheet and strip Stainless Steel. McLouth Steel Corporation, Detroit 17, Michigan.

McLOUTH STAINLESS STEEL

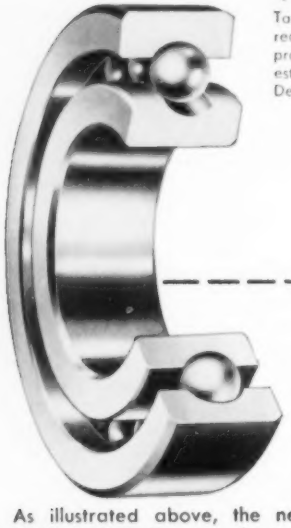
BEARING SELECTION IS AN IMPORTANT FACTOR...

in 12 Out of 14 Design Engineering Problems...



Tabulated results of a recent survey showing the problems receiving greatest attention from Product Designers.

→ Can NICE Help YOU?



As illustrated above, the new UNIBAL Ball Bearing features solid inner and outer raceways, with deep, unbroken ball grooves, PLUS a full complement of balls.

Yes, whether it be new product design, reduced costs, quieter operation or any of 12 of the 14 principal design engineering problems, the selection of bearings is a major consideration. And NICE BALL BEARING COMPANY produces complete lines of precision, semi-precision and unground standard and special bearings. Hence, NICE field and factory engineers offer the advantage of a diversified product and experience... and are well qualified to recommend or design the economically and functionally correct bearing for your particular application.

The new UNIBAL®, a NICE ball bearing of revolutionary design†, has opened up an entirely new area of savings and design improvement possibilities.

Have you investigated the design and cost saving opportunities offered by the NICE Line?

NICE®

†Patent Applied For

NICE BALL BEARING COMPANY
NICETOWN · PHILADELPHIA · PENNSYLVANIA
DIVISION OF CHANNING CORPORATION

tions and dimensions of standard relief valves. Fluid Controls Inc, 1284 N Center St, Mentor, Ohio.

Circle 35, Reader Service Card

SPECIAL-PROPERTY FLUIDS—Bulletin, 4 pp. Summarizes general physical properties of 20 selected functional fluids. Monsanto Chemical Co, Organic Chemicals Div, Lindbergh and Olive St Rd, St Louis 24.

Circle 36, Reader Service Card

FIVE-DIGIT VOLTMETER—Data sheet 19-27, 2 pp. Describes Model 501 dc digital voltmeter, including specifications, mounting, controls and readout. Kin Tel Div, Cohu Electronics, Box 623, San Diego 12, Calif.

Circle 37, Reader Service Card

LEAD-SCREW-ACTUATED POTENTIOMETERS—Specification summary 4, 4 pp. Table lists available resistances, terminal types, and setting, power ratings, operating temperatures and dimensions. Cutaway illustrates internal construction. Bourns Laboratories, Inc, PO Box 2112, Riverside, Calif.

Circle 38, Reader Service Card

INVESTMENT-CAST ALLOYS—Brochure F-30, 132, 8 pp. Presents chemical, physical and mechanical properties of four cobalt-base and one iron-base alloy. Also includes data and recommendations on joining, machining, grinding and heat-treating. Haynes Stellite Co, Div Union Carbide Corp, Kokomo, Ind.

Circle 39, Reader Service Card

TRANSFORMERS—Brochure, 4 pp. Specification and price list for transistor-equipped, miniature, subminiature, step-down, line voltage transformers. Microtran Co Inc, 145 E Mineola Ave, Valley Stream, NY.

Circle 40, Reader Service Card

HEAT-RESISTANT ALLOY—Folder bulletin 107, 6 pp. Information on chemical composition, stress rupture properties, short-time high-temperature properties, oxidization resistance and recommended design stresses. Rolled Alloys Inc, 5309 Concord, Detroit 11.

Circle 41, Reader Service Card

ALTERNATORS WITH SILICON RECTIFIERS—Bulletin ARF-500, 4 pp. Illustrates how silicon rectifier has been combined with basic alternator. Covers standard and heavy-duty alternators. Contains specifications, operating information, design and application features. Leece-Neville Co, 1374 E 51st St, Cleveland 3.

Circle 42, Reader Service Card

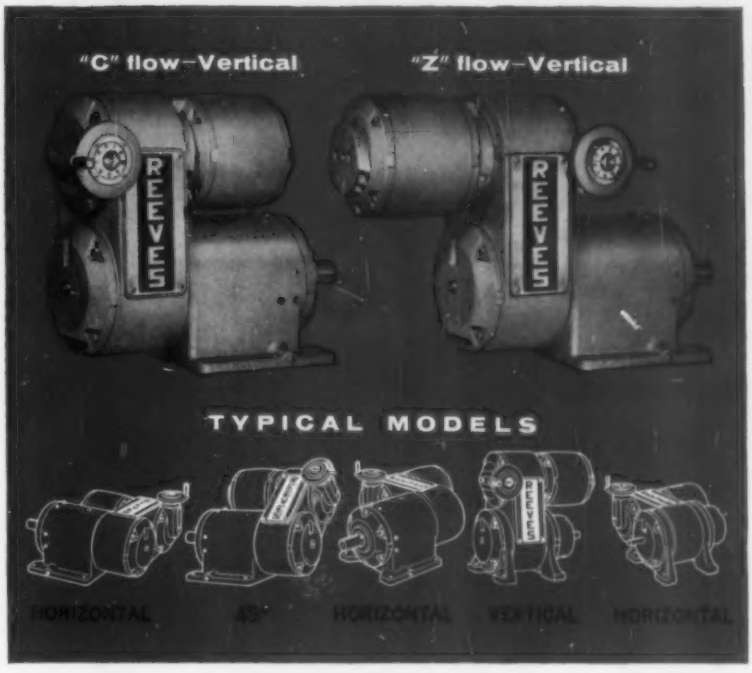
APPLICATIONS OF SOLID POLYURETHANE—ASME paper contributed

(Continued on page 114)

NEW **REEVES**®

*Sizes 200-300-400 Vari-Speed MOTODRIVES**

** 200-300-400 Sizes, 1 through 10 hp.; full line, ¼ through 40 hp.*



The flexible design of these compact new REEVES variable speed power packages permits hundreds of combinations . . . space-saving, space-fitting *standard* assemblies to meet most installation requirements. All models are available in both "C" flow and "Z" flow styles.

New increased capacity is built in the reducers—single, double or triple stages...new disc assemblies permit wider output speed ranges . . . discs are pre-aligned . . . pre-loaded spring maintains correct belt tension for longer belt wear . . . *exclusive* "close-grooving" lubrication assures free sliding discs . . . new Metermatic system automatically lubricates the motor and variable shaft bearings.

Complete information on all phases of the versatile 200-300-400 sizes Vari-Speed Motodrives is given in new Catalog. Write for your free copy today—Dept. K32c-M571.

REEVES PULLEY COMPANY

Division of **RELIANCE** ELECTRIC AND ENGINEERING CO.

Columbus, Indiana

new Robertshaw AIRCRAFT VALVES

with "wear-proof" CAPTIVE SEAL®

Even abrasive particles in the fluid or air stream cannot damage the seal in these small, lightweight Robertshaw Aircraft Valves. Balanced design exclusive Captive Seal prevents "blowouts". O-ring is held securely by steel retainer which provides *two* breaking points that instantly release pressure unbalance when seal is broken.

The complete line of Robertshaw Aircraft Valves is designed for rapid response . . . high pressure . . . low power consumption . . . no seal wear, fitting or lapping . . . and easy maintenance right in the field.

Write for complete specifications and engineering data in our new 8-page Aircraft Valve Catalog A-401.

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114 CIRCLE 169 READER SERVICE CARD

by Rubber and Plastics Div for presentation at Annual Meeting, New York, Nov 30 to Dec 5 '58. After brief review of basic processes involved in fabrication of parts, author Kenneth H Grim (manager of application engineering at Disogrin Industries) describes applications. Method of preparation of raw material is discussed, and a physical description and case histories of parts successfully made from the material are treated. Disogrin Industries, Inc, 510 S Fulton Ave, Mt Vernon, NY.

Circle 43, Reader Service Card

PLASTIC-METAL PARTS—Bulletin, 4 pp. Describes facilities and fabrication techniques. Gives specs for terminals, jacks and knobs. Whitso, 9330 Byron St, Schiller Park, Ill.

Circle 44, Reader Service Card

Letterhead Requests Only

Manufacturers who published following literature asked that requests for copies be made on company letterhead.

ALUMINUM FOIL CONVERTING PROCESSES—Hardbound manual, 244 pp. Describes converting processes and many end uses, discusses foil surface design techniques and gives data on properties and availability. Fastening aluminum foil is final chapter of 10 in book. Discusses twisting, folding, interlocking, piercing, typing and riveting in miscellaneous mechanical classifications. Free on letterhead; otherwise, personal copies are $12.50 each. Kaiser Aluminum & Chemical Sales Inc, 919 N Michigan Ave, Chicago 11.

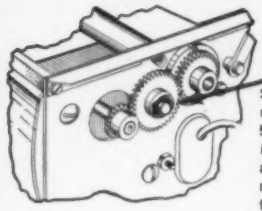
MOLDED FIBERGLASS—Brochure, 32 pp. Describes methods used to produce material and material itself. Illustrated with photos, line sketches and charts. Lists mechanical, electrical and chemical properties. Molded Fiber Glass Co, 4826 Benefit Ave, Ashtabula, Ohio.

ROLLER CHAIN AND SPROCKETS—Catalog No. 6, 98 pp. Discusses design and construction of roller chains and components; describes available units; gives dimensions, capabilities, prices. With photos, diagrams and dimensional drawings. Acme Chain Corp, Holyoke, Mass.

PEARLITIC MALLEABLE CASTINGS—Hard cover handbook, 76 pp. Four chapters cover introduction to material, castings, facts and figures for design, and applications. Three charts contain information necessary to translate basic design needs into pearlitic malleable specifications. 10 tables, 19 charts. Free to anyone responsible for materials specification or selection. Malleable Research and Development Foundation, Granville 1, Ohio.

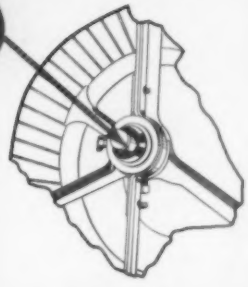
Truarc Rings Eliminate Parts and Machining, Speed Assembly, Reduce Manufacturing Costs

Ring eliminates nut and threading, saves $365/M



Sanborn Co., Waltham, Mass., uses a Waldes Truarc Series 5555 Grip ring* to secure the idler gear assembly of its portable electrocardiograph. The ring assures faultless gear performance necessary for diagnostic accuracy, eliminates a nut and threading operation for savings of $365 per 1000 units.

Ring saves parts, speeds assembly for savings of $260/M

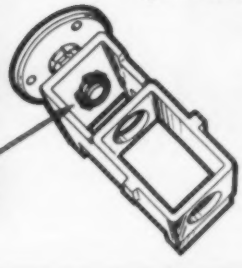


Fraser and Johnston Co., San Francisco, Calif., uses a Series 5555 Grip ring* to secure the fan shaft and speed assembly of its furnace blowers. The ring eliminates a collar and set screw for savings of $180/M on materials, $80/M on assembly time—a total of $260 per 1000 units.

2 standard rings replace 4 special parts, save $170/M

Sanymetal Products Co., Inc., Cleveland, O., uses a Series 5005 Self-locking ring and a Series 5103 Crescent® ring* to hold the escutcheon plate and handle of this doorlatch for toilet compartments. The two standard rings replace four expensive chrome-plated brass parts for savings of $170 per 1000 units.

Ring replaces spring and washer; speeds assembly 50%, saves $15/M



Allen-Bradley Co., Milwaukee, Wisc., uses a Series 5139 Prong-Lock ring* to secure the adjustment knob of its pneumatic timer. Ring eliminates a costly coil spring and washer, simplifies a tough assembly operation. Cost saving: $15 per 1000 units. Assembly time saving: 50%.

Whatever you make, there's a Waldes Truarc Ring designed to save you material, machining and labor costs, and to improve the functioning of your product.

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*Covered by one or more of the following patents: Nos. 2,382,948; 2,491,306; 2,574,034; 2,755,698.

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tangents...

1984—in Gadgetland

Twenty-five years from now—assuming we haven't all been atomized to become fallout and that the sociologists, economists, et al, have caught up with technology, here's a typical urban morning (and that's for everybody—farms are mechanized and operated by commuters, just like everything else):

Morning becomes electronic . . . You awaken in an air-conditioned room with mountain-flavored air to the strains of pre-selected music. Coffee, heated by a pre-alarm dielectric unit, awaits you in disposable coffee-flavored cups. With it and a cigarette (the cancer-causing ingredient—and cancer itself—were finally beaten in 1965), you watch the morning news on the color-TV wall across the room. Electroluminescent panels shed a light colored to suit your mood, 20 times above 1950 standards, but polarized to prevent glare. You whistle through an automatic-scented detergent shower and dry-off cycle which includes your daily ration of sun-ray, shave electronically, and step into disposable-paper underwear, shirt and socks fresh from their plastic sacks. Water is no problem—you have desalted, purified sea water in abundance. Your suit, of synthetic fiber, has heat control built in, the decorative clasp which replaced the necktie in 1970 is also a miniature 2-way radio with throat microphone.

The house is a pleasant and relaxing series of curves, mostly plastic, with the special rooms you can afford buckled on—one for each child, a photo room, a shop with machines, game room. Main rooms (like all buildings) are assembled with adhesives and have plastic-pellet insulation. The floor is plastic over a foamed-concrete heat-tubed slab.

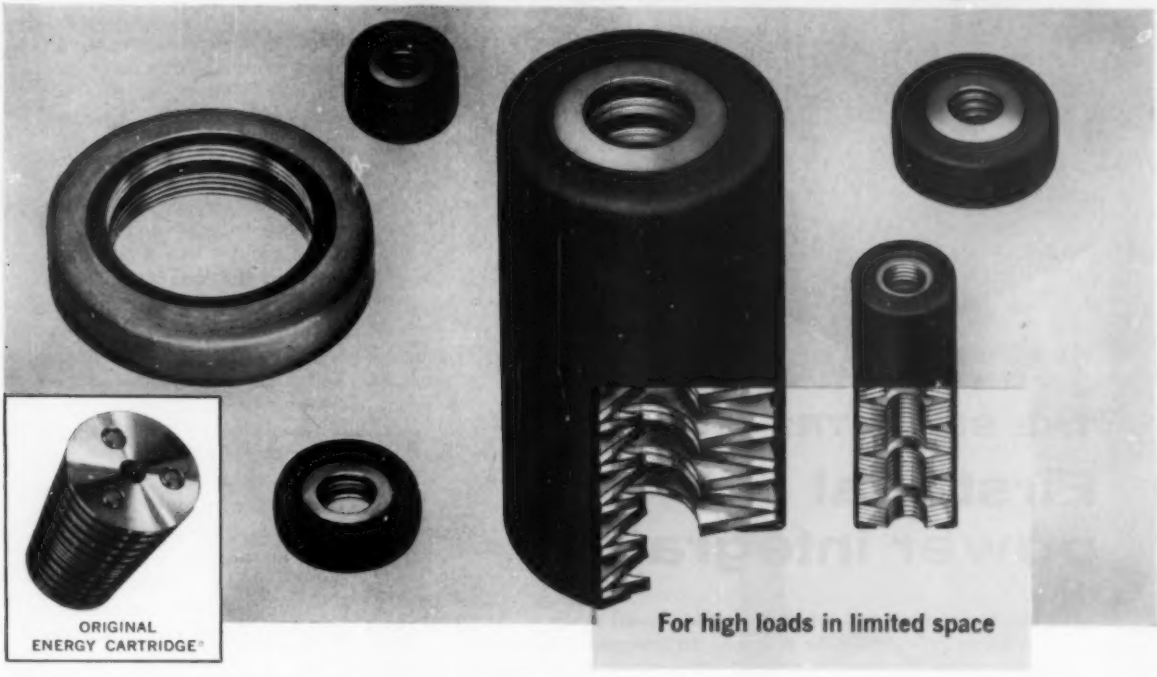
Breakfast, preselected, is ready just as you enter the kitchen. It includes cereal, dehydrated eggs and bacon, milk, coffee, all from metering hoppers. Appliances, all built in, have no moving parts, including the ultrasonic dishwasher, which washes what few dishes and pans there are and has attachments to clean the plastic walls, floors, windows. You worry, vaguely, about current proposals to synthesize all foods from cereal pellets replete with vitamins, minerals, proteins—with flavor added by you before you eat. Arguments for the plan are simplified delivery, no waste, elimination of shopping bother and the inefficient grass-animal-meat-protein cycle of food production.

As you go toward your carport (or heliport, if you have the funds), you pass unthinkingly a small box that is the electronic control center. It lights panels as you enter a room, maintains proper temperatures and air purity room by room, energizes heat conductors under walks and driveway when it snows, waters the lawn (a dwarf grass that needs no cutting and chokes out weeds), and charges and purifies water in the swimming pool. It also warms up the car, calls a repairman if a servo-mechanistic rumble develops in a wall, lets the cat in or out, and shows on a meter how much has been deducted from your bank account the most recent 4-week-period (13 per year) for all these services. But that's not unusual—most purchases are now similarly handled with credit cards that register purchases automatically with magnetic ink.

Transports of delight . . . Your leased commuter car is a plastic bubble with charged particles in the plastic to dim excess light. The exterior is corrosion proof; appropriate parts are of grease-filled powder metals. The old 1958 fins are there—but now serve as air brakes when needed. You control both the gas-turbo drive and direction with a stubby joystick control—and then only to the apron of the superhighway. There a program control takes over, feeding you into a lane and holding you over a strip set in the roadway, properly spaced from other cars. The roadway is plastic, tinted for identification, laid by machine. Radar positions you and other cars, "reads" signposts, prevents crackups, so you can read or hear the morning news. The programmer sets you off at a pedestrian-belt station, then parks your car. A passenger belt and its auxiliaries

(Continued on page 118)

ANNOUNCING... Flexi-Pak ELASTIC-COVERED* Energy Cartridges*



Preassembled belleville spring washers are now available in elastic-covered units in addition to those held together by rivets. Known as Flexi-Pak, molded coverings of rubber, neoprene, or other elastic material can be applied with the washers under tension, or latex coating can be applied under no-load conditions. In either case, washers form integral spring units for applications involving heavy loads in limited space.

Designed for use on washers with narrow walls, or where there are clearance restrictions, the elastic covering insures correct installation or removal of the washers assembled in any sequence. (See cutaway illustration above.) This is especially important where washers are stacked in varying sequence.

As a companion to the previously announced Energy Cartridge held together with rivets or pins through the neutral axis, the elastic-covered units add to the versatility of this increasingly useful type of heavy-duty spring for stripper or die use, machine mounts and drives, constant-force applications, etc.

A.S.C. Divisions are ready to help you use this versatility to advantage with Energy Cartridges tailored to your needs. For more information, write for "Flexi-Pak" folder.

*Patents—Energy Cartridge—U. S. #2,482,449
Elastic-Cover—U. S. #2,432,717

Associated Spring Corporation

General Offices: Bristol, Connecticut

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B-G-R Division, Plymouth and Ann Arbor, Mich.
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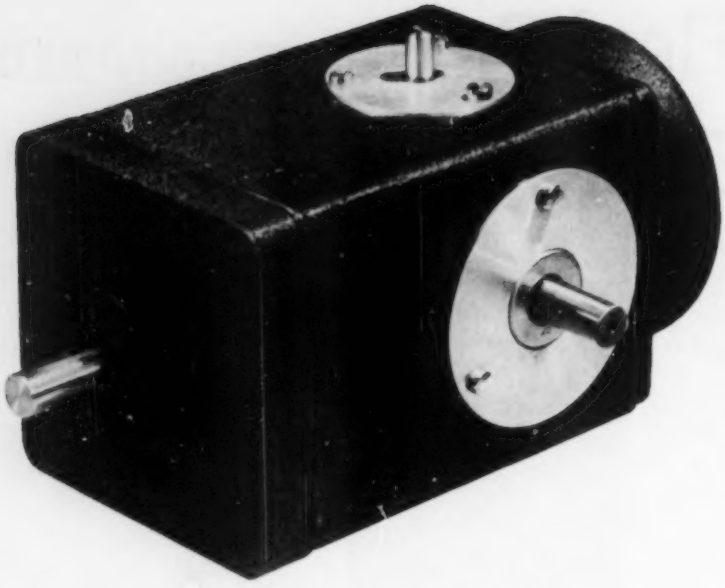

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First real power integrator

The high torque and infinitely variable speed range of the Servotran provide for the first time an integrator with real power capacity. With input shaft either running or not the control shaft may be shifted full range (±15°) with 3 or 4 in. oz. torque. Positive control is maintained on the output shaft at all times.

At constant load accuracy and repeatability are within ¼%. Input shaft speed is from 0 to 3500 rpm. Output shaft speed is infinitely variable from 0 to ±0.9 of input shaft speed. Power capacity up to 1/10 hp at full speed.

APPLICATIONS

Applications for the Servotran are limited only by the imagination. They include integrating control systems, automatic weighing, computing systems, machine feeds, process controls, recorders . . . in fact any application where low torque shifting, higher efficiency, wider speed range and low noise levels are important.

SEND FOR INFORMATION

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take you comfortably to your office under a plastic roof.

The news is of lunar labs, space vehicles, scientific round trips to Mars, rocket probes of Mercury, anti-gravity, anti-matter, ESP, chemical synthesis of living matter. London is an hour by rocket from New York—little more than commuting time. Space travel is limited, however, by the need to prove the trip is necessary before an interplanetary passport will be issued.

Executive Suites . . . At the office, your secretary has the overnight messages—teletypes and radio tapes—waiting, and is busy programming the computer for inventory data. Typewritten letters have been obsolete for five years—the typewriter is used only for composition and a few records. You listen to the morning's mail, dictate on tape, hold a conference or two by closed-circuit TV, make phone calls by pressing a button and dictating the number to a gadget called Audrey. This is the recently perfected visaphone which incorporates a TV view panel that can be switched off. They are even trying out machines that will translate if necessary, so you can carry on a conversation with anyone anywhere.

Magazines on your desk (there is still too little time to read) feature plans on what the government plans to do with the weather next year, sub-

(Continued on page 120)

"Somebody fixed your light while you were out to lunch."

The Human Eye, Nature's inspiration for the camera, can convert wavelengths of blue-green light measuring as little as 400 microns into visual perceptions that are truly life-size. Yet this entire human mechanism occupies space less than 1″ in diameter.

Tiny New Potentiometer, shown actual size, is designed to add space-saving precision to missile and aircraft servo mechanisms. Two MPB bearings in it assure accurate, low-torque shaft rotation — a vitally important benefit in sub-miniature components.

Man With Miracles. This is Maurice Hebert, one of MPB's Sales Engineers. He'll personally help you choose the correct MPB bearing to reduce friction and increase the precision of your instruments — while keeping your operating costs low with trouble-free service.

Miracles in Miniaturization

ACTUAL SIZE OF THE MPB BEARINGS IN POTENTIOMETER SHOWN ABOVE

The Smaller The Better is often completely true. Engineers now know that miniaturization is the surest method of developing new or improved components for many of the latest developments in modern industry. But, as components become smaller, the problems of maintaining high precision and long service life become larger — and the call for MPB bearings constantly increases. MPB answers with the most experienced engineers in the miniature bearing industry, and advanced research facilities . . . producing over 500 types and sizes of bearings from ⅜″ O.D. down, with specials as required. We welcome your request for engineering advice, our catalog, or both.

Write Miniature Precision Bearings, Inc., 201 Precision Park, Keene, N.H.

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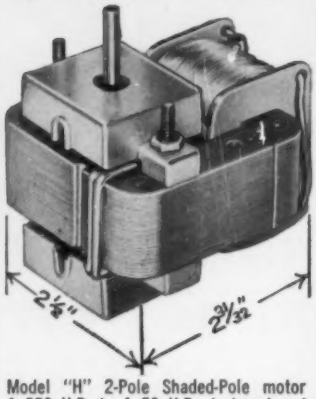

Model "H" 2-Pole Shaded-Pole motor 1/550 H.P. to 1/50 H.P. designed and constructed with features that assure thousands of **extra hours** of service under the most adverse operating conditions. Rugged, quiet, smooth running. Available in nine models that cover a wide range of applications.

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Oversized oil bearing reservoirs hold considerably more oil and wicking. A revolutionary new method of packing the wicking assures equal distribution of oil at all times resulting in quieter operation and longer trouble-free life.

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The new "H" Motor design includes a rugged die-cast bearing bracket that insures permanent precision alignment and adds to the over-all durability.

Motors For All Types of Applications

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ject to approval of the UN Meteorological Council. They're concerned with growth capital for Antarctica, the battle over spectaculars projected against clouds, and thought-control merchandising. On the daily science tape, there's a medical roundup on chemotherapy for virus infections and mental illness, tantalum bone, polyethylene heart valves and no-kink nylon arteries—but no explanation yet for the common colds and baldness. And there's also a story about the new techniques of atomic blasting to release vast reserves of oil from shale and tar sand, while strip-miners extract and pulverize both coal and ores without blasting. But the big story is of the final falling out between the old Communist friends—the USSR and Red China. Their party lines have diverged too far for recovery, and Red China is now the major power of Asia.

Back to 1958 . . . Preceding paragraphs are still dreams, of course, and assume that UFO's will be friendly if identified, that we'll still be developing solar energy and that somebody will not have hit the panic button. Our selection of 1984 was intentional, because of George Orwell's mind-searing book, and we've drawn from an endless number of sources, including our own Economics Dept, editors of other McGraw-Hill magazines, books, magazines and specialists. —EJT

"Something tells me this job is going to make us change our slogan . . ."

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18-8 TYPE 303 STAINLESS

UNIVERSAL JOINTS

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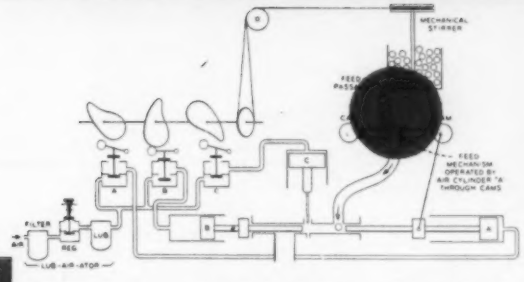
***Progress** in designing air systems:*

Here's another automating idea: Schrader Air Products in a multi-step punching system

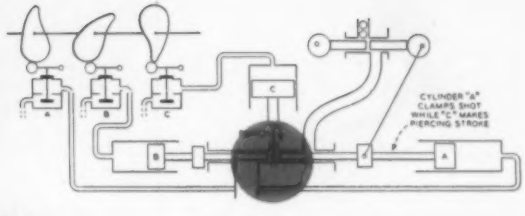
PROBLEM: To pierce tiny balls of lead shot, fast, accurately, and economically.

Schrader Products successfully performing at prominent Western plant—feeding, shot-piercing, ejecting—all automatically with air.

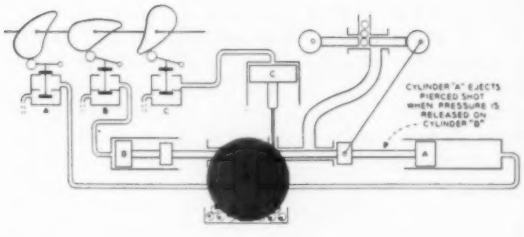
SOLUTION: Schrader Air Products designed into a system for automatic operation.



1 **FEED:** Performance of the cylinders in this system is controlled by cam-actuated Schrader valves. Cylinder A controls split-cam feed; allows the shot to be fed into the machine one at a time.



2 **PIERCE:** The shot is pushed forward and clamped at the piercing station by cylinder A and cylinder B. Cylinder C pierces the shot.



3 **EJECT:** Cylinder B returns to its initial position. Cylinder A completes its forward stroke, ejecting the pierced shot. And cycle starts again.

Air's benefits apply in almost any operation you can name: stamping, forming, programming, squeezing or measuring. And the advantages are more important today than ever: speed, accuracy, safety, simplicity, versatility, and—amazing economy. Schrader components are a natural for the designer because they comprise the only complete line of air products to select from. They can be used singly or in combination to perform jobs of amazing variety and complexity. When you design, think of air, and make use of Schrader's engineering facilities to help you specify the right products for your idea. Mail the coupon today.

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DIVISION OF THE FIRESTONE TIRE & RUBBER COMPANY

DESIGN ABSTRACTS

Finishes and Tolerances

The relative costs of various grades of surface finish and dimensional tolerances are discussed, and several examples of savings achieved by fitting specifications more exactly to service requirements are given. Bar graphs, tables and curves give data on relationship of surface finish and tolerances to performance and costs.

"Cost of Tolerances and Finishes," R C Johnson, Bureau of Ships; Journal of American Society of Naval Engineers, Nov '58, 1012-14th St NW, Washington 5, DC.

Bench Wear Tests in Materials Development

Two types of wear tests are described. How test results may be correlated with performance figures—even when test conditions do not seem to duplicate service conditions—is explained. Effects of lubricant type and material composition are described.

"Use of Bench Wear Tests in Materials Development," Robinson, Thomson, Webbere, General Motors Corp; SAE Paper 17S, 485 Lexington Ave, New York 17.

1958 ASME Annual Meeting, Nov 30-Dec 5

See PE—Dec 29 '58, and Jan 5 '59 for other papers. For copies: ASME, 29 W 39th St, New York 18.

Synthesis of Path-Generating Mechanisms

A general method is presented for synthesizing plane, linked mechanisms obtainable from a single, closed kinematic chain. Using complex numbers and the matrix theory of linear systems, these methods have been applied to 4-link mechanisms for generating a path through up to 5 arbitrary points with prescribed corresponding crank rotations.

"Synthesis of Path-generating Mechanisms by Means of a Programmed Digital Computer," Freudenstein, Columbia University, and Sandor, Time Inc, ASME paper 58-A-85.

Two on Creep

"Correlation of High-temperature Creep and Rupture Data," (Hans Conrad, Westinghouse Electric Corp, ASME paper 58-A-96) reports an evaluation of existing equations most frequently employed in correlating that indicates they all have one or more major shortcomings. A new equation is proposed which is said to be in better agreement with experimental and theoretical information. Rupture data is developed for several alloys.

"A General Solution to the Practical Solution of Creep Problems," (Mendelson, Hirschberg, Manson, NASA, ASME paper 58-A-98) presents a general method for solution of creep problems, by use of successive approximations. Application of method, various creep laws and loading plots are illustrated.

Dimensioning of Machine Assemblies

Statistical procedures used in quality control and acceptance sampling methods developed for maintaining standards in individual machine parts are applied to dimensioning of assemblies. Standard deviations, dimensioning of clearance fit, dimensioning of assembly with unknown deviations, overlapping tolerances are discussed.

"Application of Statistics to Dimensioning of Machine Parts," M. F. Spotts, Northwestern University, ASME paper 58-A-44.

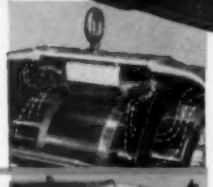
Effect of Mean Stress on Fatigue

The concept that alternating shear stress is primary cause of fatigue, with normal stress on critical shear plane as an influencing factor, has been developed—particularly for the case of mean (or static) stresses super-imposed on combinations of torsion and axial load or bending. The theory explains the fact that influence of mean stress is weak for torsion and stronger for bending of ductile metals, but strong for both torsion and bending of cast irons. This is probably first rational theory for influence of mean stress.

"A Theory of the Effect of Mean Stress on Fatigue of Metals Under Combined Torsion and Axial Load or Bending," W. N. Findley, Brown University, ASME paper 58-A-61.

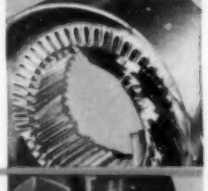
NEW R&M Re-Rated Series 254U All-Weather Motors

"straight through" dual-sweep ventilation eliminates "hot spots"



full height end head protection

Mylar insulation increases motor life*



bearings easily inspected by removing cover plate

permanently numbered leads simplify installation and maintenance

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Premium Performance

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R&M Series 254U Motors help pay their own way from the minute you flip the switch! They stoutly resist any hostile environment—moisture, dirt, heat, acid or alkaline fumes—and so live longer. They have push-pull ventilation that won't let dirt settle and keeps motor internally cool—and so perform with full, brisk efficiency. Their oversize bearings are quick and easy to inspect and relubricate—so your maintenance costs dwindle.

This long, trouble-free, vigorous motor life is what R&M means by "Premium Performance"—an extra reward in service and savings every R&M motor offers. These and other big, money-saving advantages shown at left cost no more . . . R&M motors carry standard motor prices!

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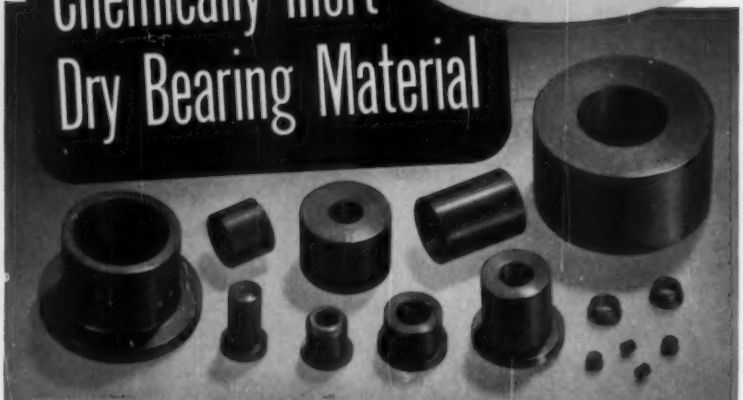
PROPELLAIR FANS

Chemically Inert Dry Bearing Material

Chemloy 719



use without lubricant!

Chemloy 719 is proving to be the most *universal* dry bearing material ever offered to industry:

. . . because its extremely low coefficient of friction invites use where lubrication is impossible, impractical or undesirable.

. . . because it may be used on both sliding and rotating applications over a wide temperature range.

. . . because it is impervious to practically all known chemicals, solvents or corrosives.

. . . because it is excellent under vibration or shock service conditions.

. . . because it will not conduct electricity or cause galvanic corrosion.

Chemloy 719 is available in all basic forms—such as sheet, rod or tubing—or in parts molded or machined to specifications. Get full details.

Request Bulletin T-120 and Price Sheet No. 126, or send b/p or specs. for quotation on molded or machined parts.

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CRANE PACKING COMPANY

NEW BOOKS

Centralized Information Services

ALLEN KENT, JAMES W PERRY. *Interscience Publishers, Inc, 250 Fifth Ave, New York 1. Paperbound, 8½ x 11, 156 pp. $5.*

Information services in this country are decentralized and pretty much independent. Each company and government agency has established its own organization to perform such services as preparing abstract bulletins, compiling indexes, making searches. A central agency that would collect and distribute scientific information would be faster and more efficient. This report presents results from a number of surveys made to investigate advantages and feasibility of a centralized information service.

Most of the surveys reported here were made via questionaires quizzing members of Special Libraries Assn, managers of metal companies, leaders of professional and technical societies. Tabulated results and conclusions from these surveys form the bulk of the report. Sample questionnaires are shown in the appendix.

Chamber's Technical Dictionary

Edited by **TWENEY** *and* **HUGHES.** *MacMillan Co, 60 Fifth Ave, New York 11. 5½ x 8½, 1028 pp. $7.50.*

This dictionary gives definitions of terms that are of importance in pure and applied science, in all branches of engineering and construction, and in the larger manufacturing industries and skilled trades. It was written by specialists, partly for other specialists but more particularly for the technically minded man-in-the-street, and for students and interested workers of all kinds and ages: indeed, for all who wish to understand what scientists and engineers have to say to each other.

Reliability Bibliography—Supplement 1

Available from Office of Technical Services, Dept of Commerce, Washington 25, DC. 8 x 10½, paperbound, 168 pp. $3.

The Naval Electronics Laboratory has included in this supplement abstracts of over 600 articles on relia-

(Continued on page 128)

Anodized grille of Penmetal Multimesh blends elegance with strength

Color and texture are excitingly combined in this golden grille of Penmetal expanded aluminum. The new patented Multimesh pattern has depth and variety. Gives, in fact, an air of elegance to the handsome "hi-fi."

Penmetal expanded metal has the strength to withstand the abuse of everyday use; the rigidity to span large areas in an unbroken sweep. What's more, the open mesh permits free passage of sound. The color is an integral part of the metal surface . . . for permanent brightness.

Get one-of-a-kind beauty for *your* product with any of the new Multimesh patterns: Crystal, Pendant, Garland.* Easy to work with. Easy on your pocketbook.

Folder 516-EM gives sizes and dimensions of Multimesh. Write for a FREE copy today.

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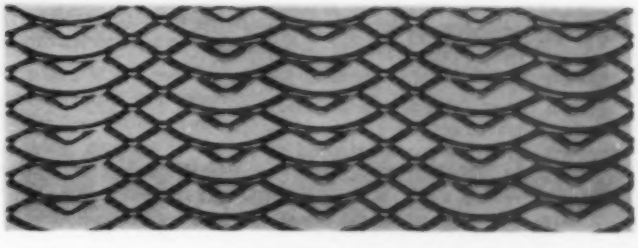
Penmetal

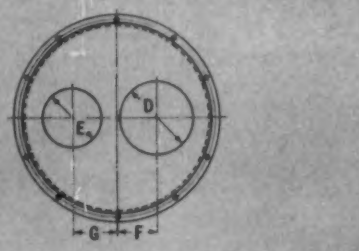
a name to remember

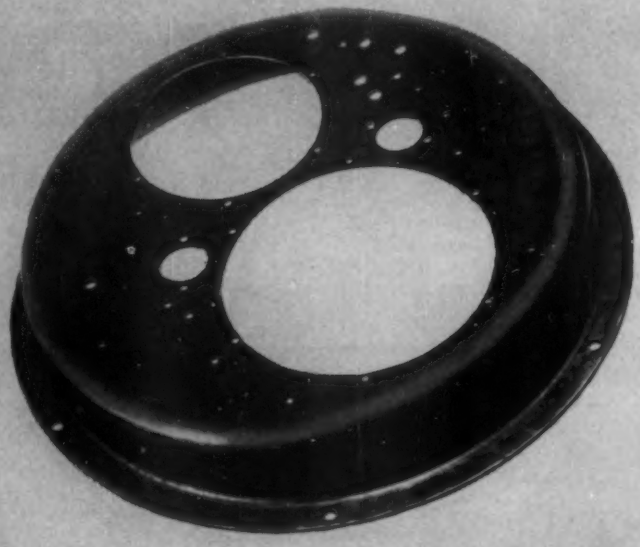
"Stereotron" stereophonic unit by Griffith Company, Parkersburg, W. Va., features a gold anodized grille of Penmetal's Pendant Multimesh.



*All designs are patented.

PM-199





A	B	C	D	E	F	G
36	40	6¼	16¾	12⅜	7	8⅝
48	53	8½	20	16½	11¼	10¾
60	65⅛	12⅛	23⅜	18⅜	12⅝	14

Cuts costly operations on component part

One operation pin points 63 holes in dish-stamped 60" diameter boiler door—completely eliminates accumulative error

Exact dimensional sizing and accurate placement of all holes—eliminating any chance of accumulative error—is a primary requirement in the dished boiler doors being produced for the Cleaver-Brooks Company.

Equally important is close adherence to a tolerance of plus or minus 1/16" on diameter, and flat across the flange within 1/16"—even after the gang-piercing operation in order to guarantee perfect fit and draft-free closing seal.

Gang-piercing of the required holes in the Cleaver-Brooks boiler doors—involving a one-hit operation—insured identical dimensional and location accuracy of all holes at lower cost.

When other fabricating methods proved unsatisfactory and too expensive, Cleaver-Brooks turned to COMMERCIAL. Dies for the stampings were designed and produced by COMMERCIAL and the boiler doors are now turned out on a regular production basis on a 2000 ton mechanical press with an 8 x 16 ft. bed and a 30 in. stroke.

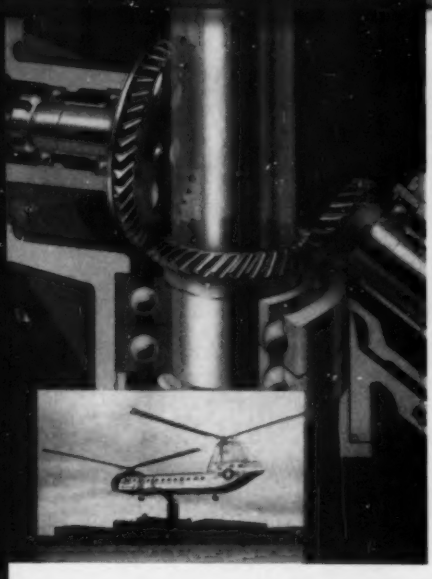
The close dimensional tolerances of the multiple holes in the boiler doors eliminate the need for further reaming. The exact spacing of all holes, which is completely free of any accumulative error, makes it possible to mount boiler accessories directly to the boiler doors without any assembly time lag. Also eliminated, thanks to gang-piercing, is the need for any flat surface facing before accessories can be mounted.

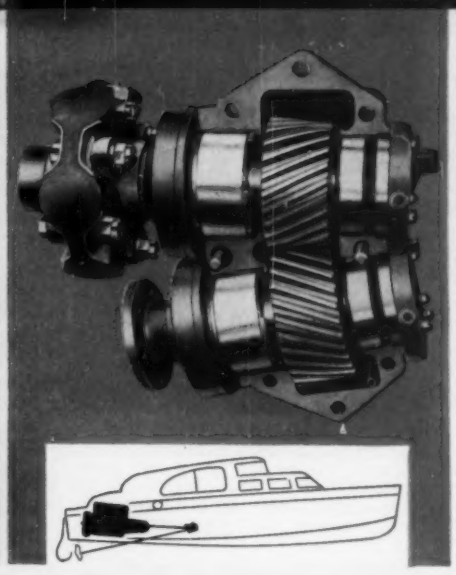
Other costly and time consuming operations formerly required, such as flame cutting, rolling rings, machining edges, welding, weld inspection, cutting holes, etc., not to mention the use of many expensive fixtures, have now all been eliminated by the heavy stampings produced by COMMERCIAL.

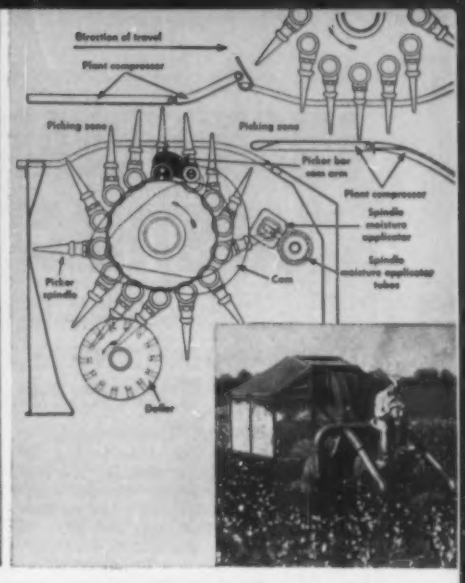
The greater accuracy afforded by the stamping method obviously leads to many important savings in the complete production operation—invariably means lower product cost. Because accuracy in stampings is identical—almost automatic—it involves no time lag, requires less man and machine hours to gain. At the same time, greater accuracy naturally means fewer rejects and less waste of raw material.

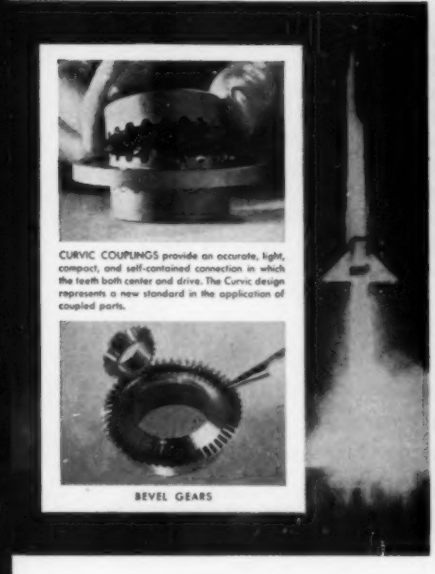
Whatever your particular component part design problem may be, we may be able to suggest and help you work out a practical and economical solution based on our more than 30 years' experience in forming metals. Send details of your problem to Commercial Shearing & Stamping Company, Department G-4, Youngstown, Ohio.

COMMERCIAL shearing & stamping



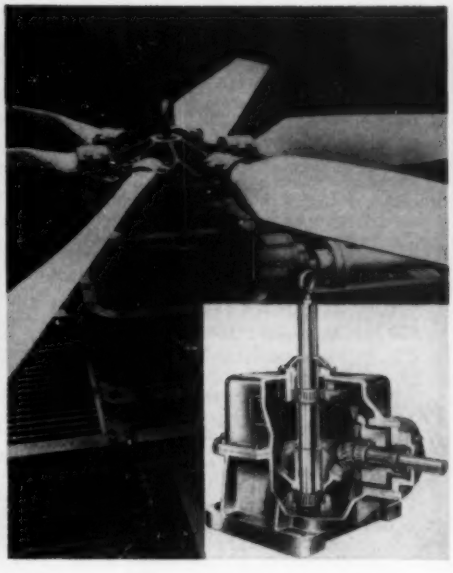


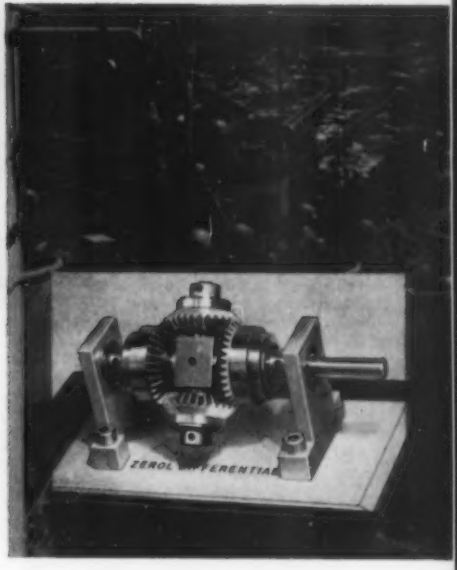




CURVIC COUPLINGS provide an accurate, light, compact, and self-contained connection in which the teeth both center and drive. The Curvic design represents a new standard in the application of coupled parts.

BEVEL GEARS





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More flexibility. Instead of designing *around* your transmission, you can design a transmission *into* your products with angular drives.

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Greater accuracy. Using Gleason machines and methods you can grind or cut bevel gears to exceptionally close tolerances. The complete accuracy and reliability needed in the *missile* and *fire control unit* are obvious.

Heavier loads. An angular drive can stay compact and still carry heavy loads such as the one on the gear reducer in the *cooling tower fan*.

Full engineering help. A large and competent staff of Gleason engineers is yours to call on for help in early design work, for the manufacture and testing of prototypes, for selecting and setting up of machines and methods, and for any other assistance you might need.

Free literature. To become better acquainted with the advantages and the theory of bevel gear drives, send for these Gleason Manuals:

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CIRCLE 183 READER SERVICE CARD

MICRO-BEARING ABSTRACTS

by **A. N. DANIELS**, *President*
New Hampshire Ball Bearings, Inc.

BEARING FITS AND FITTING PRACTICES

As shown in *Fig. 1*, the fitting of Micro-Bearings, like the fitting of larger ball bearings, chiefly involves the clearances between the inside diameter of the housing and the outside diameter of the bearing; the bore of the bearing and the shaft diameter.

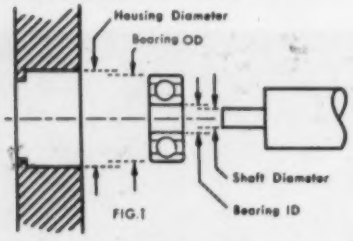


FIG.1

The achievement of the desired fit by dimensioning is illustrated in *Fig. 2*. The bearing ID is represented by the top blocks and the shaft OD is represented by the lower blocks. Such a block diagram could also be applied to housings and bearing outside diameters. In this block diagram, it will be noted, the bearing ID is represented by a .00015 tolerance with a similar tolerance for the shaft. A resulting fit of line to line to .0003 loose is shown.

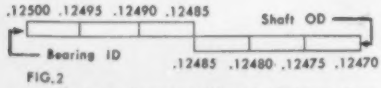


FIG.2

An interference fit not tighter than line to line is suggested for the following reasons:

1. *Difficulty in assembly.*
2. *Difficulty in disassembly. This is often more hazardous than the assembly operation and may result in total bearing destruction.*
3. *Reduction in radial play.*
4. *Danger of bearing ring conforming to possible poor geometry of mating shaft or housing.*

TOLERANCE DISTRIBUTION

The maximum .0003 loose condition shown in *Fig. 2* may be excessive in some applications. The fitting problem then resolves itself to reducing this extreme, and yet maintain the maximum tight fit of line to line. The looseness may be reduced by redimensioning the shaft to .12490/.12475 as shown in the block diagram, *Fig. 3*.

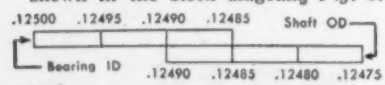


FIG.3

If the frequency distributions of shaft and bearing ID sizes were statistically normal, the modal fit of all parts would be 0.0001 loose. Accordingly, an insignificant percentage of parts would be mated to the extreme values, and for practical purposes could be ignored.

With regard to bearings' outside diameters and bores, however, normality of the distribution curve cannot be assumed. During the grinding operation, the "most metal tendency" tends to skew the frequency distributions for bearing ID's and OD's in the direction of most metal.

In grinding and finishing shafts and housings, similarly skewed distributions occur.

Operating on a modified probability distribution of tolerance is possible if the volume of parts is sizeable. But the approximate distribution of shaft and housing sizes must be verified if this method is to be used.

MATERIALS and SURFACE FINISHES

The ease of assembly is also affected by materials and finishes. The following factors must be considered:

1. *The galling characteristics, hardness and ductility of the materials involved.*
2. *Finish lay patterns produced by various tools and techniques used.*
3. *R M S surface finish values achieved.*
4. *Geometry of shafts and housings as regards out-of-roundness, taper, etc.*

The possible combinations of these elements in any single application are so numerous that their gross effect can only be ascertained by trial and error, or by a detailed study of operations on individual applications. A more complete discussion of fitting practices, including sizing methods and coding, is found in our design handbook.

DESIGNERS HANDBOOK FREE TO ENGINEERS

If you work with miniature bearings, you'll find this new, 70 page authoritative publication a great help in solving problems in designing instruments or small electro-mechanical assemblies.

It will be sent free to engineers, draftsmen and purchasing agents. Write to:

NEW HAMPSHIRE BALL BEARINGS, INC., PETERBOROUGH 1, NEW HAMPSHIRE

bility which have appeared in 75 leading technical journals and trade magazines. Abstracts are divided by subject into 10 categories and printed on the page in 3 x 5 boxes so that they can be clipped and filed for ready reference. Pages are numbered for interfiling in the basic NEL bibliography which appeared in 1956.

Human Engineering Bibliography, 1955-1956

Prepared by Project Staff, Human Engineering Information and Analysis Service, Institute for Applied Experimental Psychology, Tufts University. (ONR Report ACR-24; PB 131507) Available from Office of Technical Services, Dept of Commerce, Washington 25, DC. 8¼ x 10¾, 306 pp. $4.75.

The literature associated with human engineering derives from some 490 different journals and periodicals as well as a host of publications from governmental, industrial, and academic laboratories. The present bibliography is one of a planned series which has been designed to meet this requirement. The bibliography is divided into 15 sections, arranged according to the major topical divisions within the human engineering field.

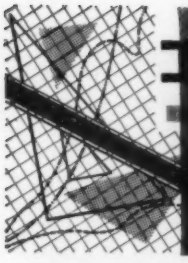
Comparative Information-handling Performance with Arabic Numerals

ALLUISI and MARTIN, *Ohio State University, for Wright Air Development Center. (PB 131562) Available from Office of Technical Services, Dept of Commerce, Washington 25, DC. 8¼ x 10¾, 18 pp. 50¢.*

Symbols generated from multi-element "printing" matrices are frequently used to represent more con-

(Continued on page 131)

"The only original thing about this design is the coffee spot!"



Molykote® DESIGN news

GERMAN ENGINEERS USE MOLYKOTE TO SLIDE 944 FOOT BRIDGE 60 FEET

The relocation of a bridge of these dimensions without the use of rollers has not previously been reported. The weight of the bridge was approximately 4,500 tons.

The results of extensive testing at the Bavarian Testing Institute at Nurenberg showed it to be more economical to move this bridge on girders lubricated with MOLYKOTE Type G than on rollers.

When writing refer to Item 503.

This bridge carries traffic of the Munich-Salzburg Highway over the Mangfall Valley.

MOLYKOTE® OPERATES EFFECTIVELY OVER -300°F. TO 750°F. TEMPERATURE RANGE

ATOMIC RADIATION DOES NOT AFFECT MOLYKOTE TYPE Z

Extreme temperatures rule out the the use of conventional lubricants. They freeze solid at extremely low temperatures or form objectionable deposits at elevated temperatures.

The missile age has further complicated lubrication problems. Not only must lubricants operate over a wide temperature range, but they must be unaffected by radiation, be capable of functioning in a vacuum, be compatible with liquid oxygen, and have indefinite storage life.

MOLYKOTE Type Z meets all of these requirements and is the only lubricant known to operate over a 1050°F. temperature range (-300° to 750°F.). In inert atmospheres, MOLYKOTE Type Z is unaffected by temperatures as high as 2000°F.

MOLYKOTE assures nearly 100% protection against galling and seizing on all low velocity extreme bearing pressure applications. With MOLYKOTE, the coefficient of friction decreases with increased loads and there is no tendency for it to be wiped away. The coefficient of friction with MOLYKOTE Type Z is .024 at 400,000 psi. MOLYKOTE maintains its effectiveness in the presence of all but a few strong acids. The problem of lubrication where abrasive dust contaminates the atmosphere is greatly reduced by MOLYKOTE dry films. MOLYKOTE Type Z conforms to MIL-M-7866A (ASG). It is the basic ingredient in the many MOLYKOTE types that are available to industry.

When writing refer to Item 501.

NEW MOLYKOTE "WEAR IN" COMPOUND REDUCES SURFACE DAMAGE RESEARCH PROVES

During the critical wear in period, permanent surface damage, variously described as "galling", "scuffing", "scoring", "tearing", "scratching", "excessive abrasion", and "seizing", is an inherent hazard.

Cross section of ground steel surface. (Redrawn to scale.)

When magnified, even highly polished metals show surface irregularities as in the drawing above.

MOLYKOTE "Wear In" Compound was developed as a result of extensive research. It drastically reduces the time necessary to accomplish wear in and eliminates the hazards.

"Wear In" damage requires costly reconditioning of new equipment and the amount of damage left unrepaired has much to do with the useful service life of machinery.

When writing refer to Item 502.

LIFETIME LUBRICATION WITH MOLYKOTE BONDED COATINGS

MOLYKOTE resin bonded lubricant coatings combine all the outstanding characteristics of MOLYKOTE with today's most advanced air-drying and thermosetting resins.

Roller Bearing Company, W. Trenton, N. J., process self-aligning bushings with a MOLYKOTE resin bonded coating. This coating provides lifetime lubrication and protection against corrosion.

MOLYKOTE resin bonded lubricant coatings are an amazing new development in the field of lubrication. They provide bearing surfaces with a wear-resistant film that has a low coefficient of friction. In many cases, the initial treatment is sufficient to lubricate parts for the lifetime of the equipment.

When writing refer to Item 504.

Self-aligning bushing manufactured by Roller Bearing Corporation of America, W. Trenton, N. J.

THE ALPHA-MOLYKOTE CORP.,
Stamford, Conn.
Please send me details on

Item 501 ☐ **Item 502** ☐
Item 503 ☐ **Item 504** ☐

Name .....
Company .....
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SEE OUR CATALOG IN SWEET'S PRODUCT DESIGN FILE

Address your letter to The Alpha-Molykote Corp., 65 Harvard Ave., Stamford, "Research City", Conn. Phone: FIreside 8-3724.

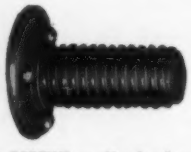
BREAKING LUBRICATION BARRIERS ...THROUGH RESEARCH

OHIO WELD SCREWS

GW SCREWS — Used where design requires a smooth unmarred surface and a fastener permanently fixed in place.

HH SCREWS — Used where a single, button-type projection is required when welding to curved surfaces, to heavy sheet 3/32" or thicker, or to ends of rods.

RW SCREWS — Used where a hermetic seal is required to prevent leakage of air, gas, water, oil or dust, or when welding to perforated metal or wires.



HW SCREWS — Used where a self-locating through bolt is required to be fixed securely in place so that it will not turn and a flush surface is required for attaching mating parts.

Thread Size 6-32 to 3/8-16

Samples and information available upon request.

The OHIO WELD FASTENERS Primary Fastener in Fastener Assemblies

THE OHIO NUT AND BOLT CO.
41 FIRST STREET BEREA, OHIO

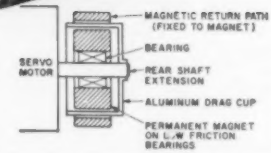
CIRCLE 186 READER SERVICE CARD

There's a lead-lag network in this SIZE 11 Frame!

EAD's Inertially Damped Servo Motors

One compact unit—EAD's high performance servomotor and an inertial damper. Electrically equivalent to a lead-lag network. This damper means: maximum velocity constants; excellent damping; line frequency insensitivity; no wiring or pick-up problems; suppression of residual noise; non-critical adjustments and no loss in shaft output. Meets significant military specs. Operates to 150° C. Supplied in sizes 10 and 15 as well.

Also available—Viscous Damped Servomotors. Write for complete data.



TYPICAL PARAMETERS Model No. SD1HLX7-2CC	
Size	BU ORD Size 11
Frequency	400 cps
Motor Power	3.5 watts/phase
Stall Torque	0.63 oz. in.
No Load Speed	6300 rpm
Magnet Damping	100 dyne-cm-sec.
Corner Freq., cps	f_1=0.3, f_2=1.6, f_3=16

EAD Eastern Air Devices, inc.
381 CENTRAL AVENUE
DOVER, NEW HAMPSHIRE

CIRCLE 188 READER SERVICE CARD

GUARANTEED

to give drip-tight leak-proof seal

greatest name in unions

DART

For over 55 years the firm guarantee back of each and every DART UNION sold has been — *"if one should leak through we will give you two"!* The record reveals that less than 1 in every 100,000 has proven to be faulty. The extra wide bronze to bronze seats, precision ground to a true ball joint, mounted in heavy malleable iron pipe ends and protected by an extra heavy union nut, make a drip-tight, leak-proof connection WITHOUT EXCESSIVE WRENCHING time and time again.

Guarantee positive tight connections and extra long service on your pipe lines by using the DART GUARANTEED UNION.

Yours on request: Descriptive brochure on Dart Unions and Union Fittings.

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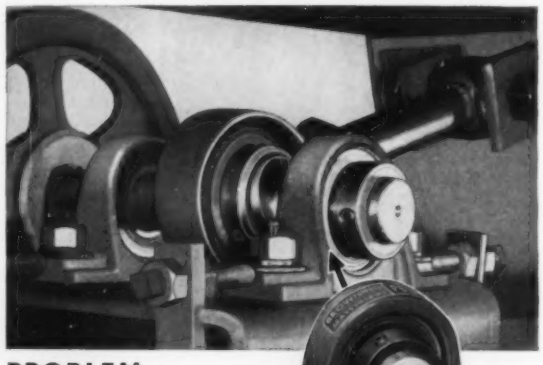

PROBLEM APPLICATIONS SOLVED with Browning BEARING UNITS

Consider ruggedness, for example. The installation of Browning pillow blocks with housings of stronger *unbreakable malleable iron* has eliminated breakdowns on the above shaker conveyor, in which high shock loads formerly caused frequent block breakage and costly downtime. The greater strength of malleable also permits a unit of less size and weight than with ordinary castings. Other cost-saving features: self-aligning ball bearing units, permanently lubricated and sealed; wide inner ring, eccentric locking ring and safety set screw. Interchangeable with other types, in 29 sizes for ½ - 2 7/16" shafts. Write for free catalog BU-101.

Browning Manufacturing Company, Maysville, Kentucky

Browning POWER TRANSMISSION EQUIPMENT

CIRCLE 189 READER SERVICE CARD

CIRCLE 187 READER SERVICE CARD

ventional Arabic numerals, such as in the automatic scoreboard used in sports. Recent study has examined the feasibility of using such visual coding schemes for displaying various types of numerical information in air traffic control.

This research was undertaken to compare the information-handling performance of subjects making verbal (number-naming) and motor (key-pressing) responses to the symbols and the conventional numerals. When verbal responses were made, the conventional numerals were consistently superior in performance to the symbolic numerals. No such clear superiority was observed for either set of numerals when motor responses were made.

Introduction to a Study of Mechanical Vibration

G W VAN SANTEN. *Macmillan Co, 60 Fifth Ave, New York 11. 9 x 6 310 pp. $8.50.*

This book reviews elementary theory of mechanical vibrations, as well as some of the more important problems encountered in practice. Since the whole subject covers a great deal of ground, from ultrasonics to earthquakes and measuring equipment to fatigue phenomena, it is possible, in this book, to only touch upon some of these aspects.

An effort has been made, however, to present each individual subject so as to demonstrate the essentials of problems and thus provide a jumping off point for a special study of any particular branch of the work.

Control System Components

JOHN E GIBSON AND FRANZ B TUTEUR. *McGraw-Hill Book Co, 330 W 42nd St, New York 36. 9 x 6, 493 pp. $12.*

This is an analytic treatment of a number of the most commonly used components in servomechanisms and other feedback control systems. Methods of analysis and basic engineering principles are presented from the point of view of the systems engineer, rather than specific discussions of commercial devices. Basic aim of the authors is the calculation of transfer functions for devices under consideration. This is not intended to be a "handbook," but rather, the reader is assumed to be a nonspecialist interested in the analysis of components in order to intelligently apply them, and is intro-

(Continued on page 134)

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Model 3040 Oil-less Air Pump. Up to 20" vacuum, up to 10 p.s.i. pressure. Capacity to 24 c.f.m.

Provide oil-free air blast with any of the carbon-vane

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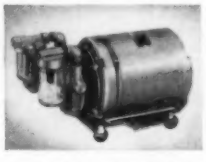
Model 0240, 0440, 0740 Series Oil-less Air Pumps. Three displacements, from 1.9 to 5.6 c.f.m. Vac. to 15", pressure to 10 p.s.i.



Model 0211-P103-G8X Integral-Motor Oil-less. Up to 1.3 c.f.m. Motor 1/4 h.p. Wt. only 22 lbs. Smaller Model 0406 Oil-less has 1/12 h.p.

Need a pump that delivers absolutely *oil-free* compressed air? A Gast Oil-less Air Pump may be your answer! Built in seven different models — vacuum or pressure — these pumps* run *entirely without oil* in the pumping chamber.

Four carbon vanes lubricate themselves. Ball bearings are grease-sealed for life and separated from pumping chamber by a ventilated space. Air flow can't be contaminated with hot oil vapor.

You can *forget* oiling maintenance problems too! Simple construction delivers up to 15,000 hours' operation without attention, depending on r.p.m. and service conditions. This is a big advantage, especially when your product requires a compressor or vacuum pump mounted in a hard-to-service location.

Widely used on food-packaging, paper-handling, folding and laboratory machines.

Write for full details — request Bulletins 152A and VP-356. GAST MANUFACTURING CORP., P.O. Box 117-V Benton Harbor, Michigan.

*Standard oil-lubricated models also available.

SEE CATALOG IN SWEET'S PRODUCT DESIGN FILE

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- VACUUM PUMPS TO 28 IN.

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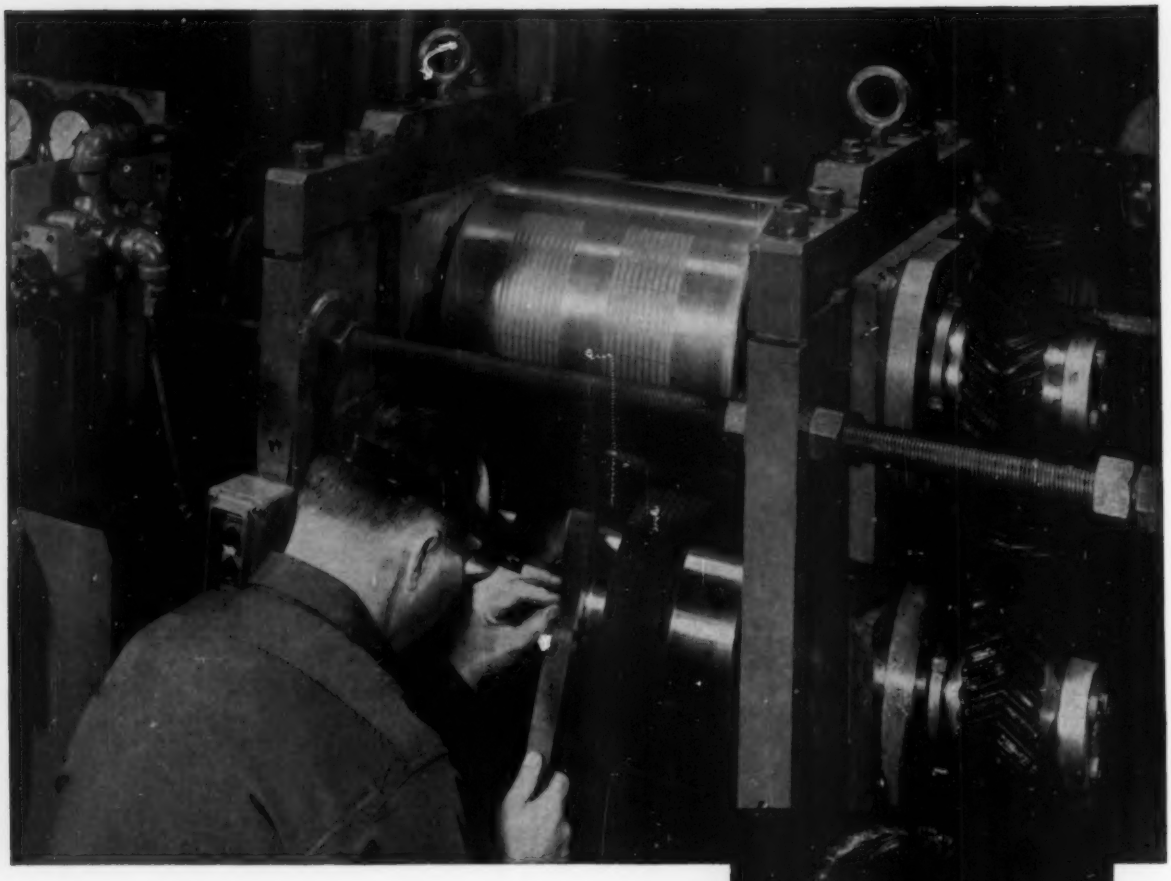

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Alclyde Engraving is in a fascinating business. Chances are the dashboard trim, instrument panels, and scuff plates on your car were embossed on Alclyde rolls—this firm manufactures the major part of all rotary register embossing rolls used by the automotive industry.

The packaging, labeling and plastics industries are also heavy users of Standard-forged, Alclyde-engraved rolls. And in all fields in which design changes are a frequent and vital competitive factor, Alclyde must deliver perfection in a hurry.

That's why we at Standard have geared ourselves to give Alclyde the quality perfection and service it requires. In fact, it's the *service* we can give that all of our customers particularly appreciate. Won't you discuss your quality *and* service requirements with us? Write Dept. 4-A.

"Yes, Standard Steel Works, in supplying us with matched, flame-hardened forged steel embossing rolls, meets our rigid specifications for steel analysis and accurate machining. Nothing is more vital to an engraver than to have perfection all along the line. But in addition, we appreciate the warm, personal relationship which exists between us. The people at Standard appear to be really interested in our business and problems," says Frank W. Broderick, president Alclyde Engraving Co., Chatham, N. J.

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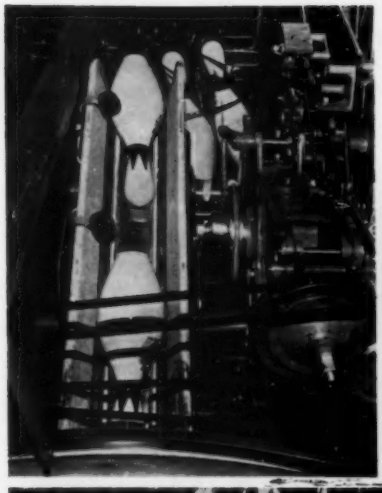
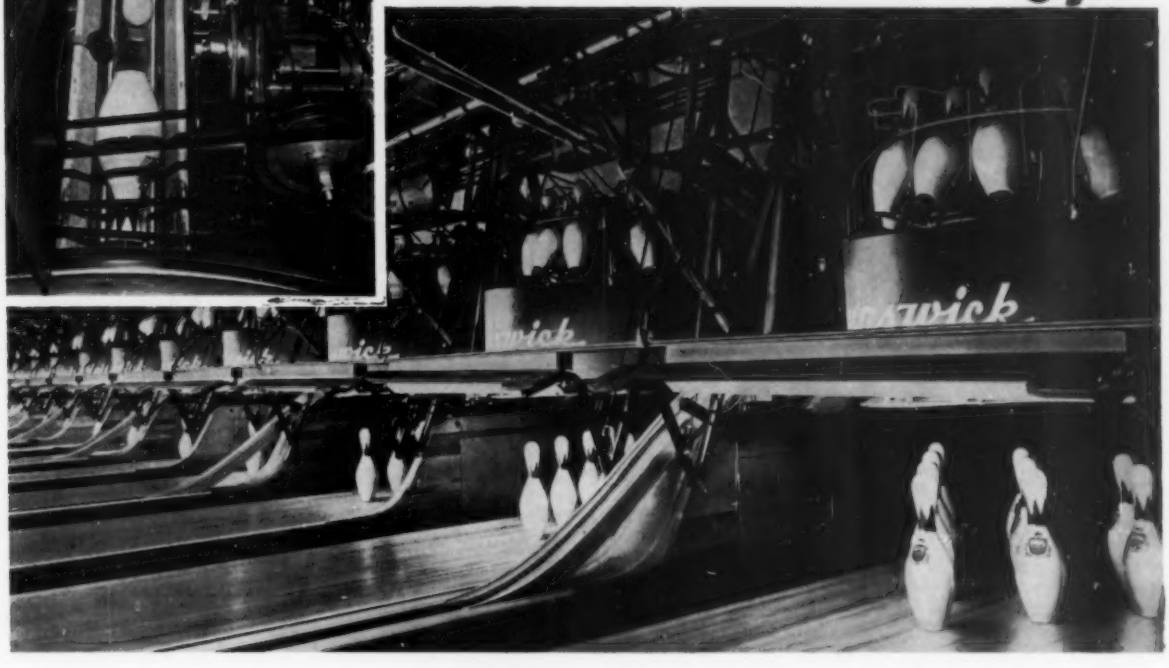


Modern Automation revolutionizes age-old sport of bowling

It's a far cry from the old "bowling alleys" and pinboys to today's ultra-modern, multi-lane bowling centers which attract millions of new bowlers each year. Much of this phenomenal growth and popularity dates from the introduction of automatic pinsetting machines which speed up the game, free it from dependence on pinboys and permit bowling around the clock.



Brunswick Automatic Pinsetters help maintain trouble-free precision with widespread use of ORANGE ROLLER BEARINGS

Few industrial machines can surpass the Brunswick Automatic Pinsetter for ingenious design—precision automation—or application of the most advanced mechanical principles and components.

In designing and selecting bearings for the many rotating, cam and oscillating motions in the pinsetter, Brunswick engineers worked closely with Orange engineers. From the wide range of Orange bearing types available, Brunswick obtained the most efficient type and construction of bearing for each specific requirement.

The solution to *your* bearing problems is as convenient as the Orange representative in your area. Call on him for engineering advice and information on Orange Roller Bearings.

Write for 40-page Engineering Reference Manual giving specifications on complete line of Orange Roller Bearings.

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Cage Type
NEEDLE BEARINGS

Used in jogger arm assembly and pit conveyor vibrating arm.

ORANGE
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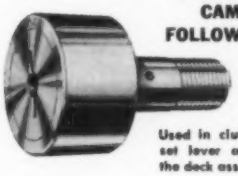
Used in deck lift shaft assembly and in drive worm input shaft.



ORANGE
CAM
FOLLOWERS

Used in clutch reset lever and on the deck assembly.

ORANGE
CAM
YOKE
ROLLERS

Used on scissor cam lever in gear box; also on rake shaft and as a rake cam follower.

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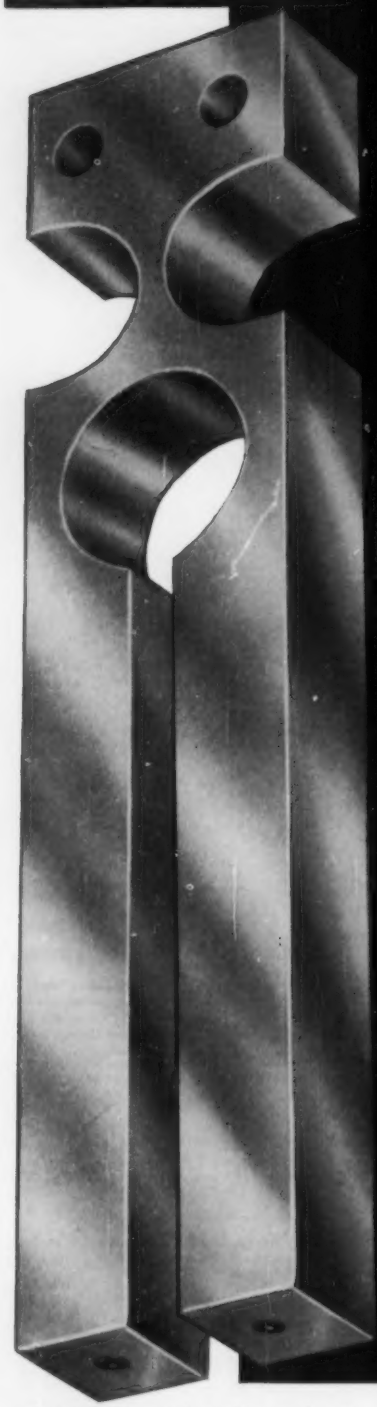

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Chatillon, maker of "the World's Most Accurate Spring" also produces Tuning Forks made of Iso-Elastic alloy for the Instrument and Electronic Field.

This remarkable, Chatillon developed alloy lends itself particularly to Tuning Fork applications due to its hysteresis error of less than .05% of deflection, drift not exceeding .02% of deflection in 5 minutes plus automatic compensation for temperature changes from −50°F to +150°F. Thermostatic control systems for the maintenance of constant temperatures are thus unnecessary. Chatillon Iso-Elastic Tuning Forks are used by General Electric Co., Daystrom Instrument and others.

CHATILLON makes Spiral, Torsion; Compression and Form Springs of Iso-Elastic material, as well as springs of conventional alloys.

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duced gradually into the more advanced parts of the discussions of electronic, electric, mechanical, hydraulic, and pneumatic components.

Recent advances in magnetic amplifiers, transistors, hydraulics, pneumatics, network synthesis, thyratron amplifiers are described, and a complete system analysis of valve-operated hydraulic systems, relay amplifiers, is given. The section on mechanical components includes gyroscopes and inertial navigation components. Class-tested problems appear at the end of each chapter.

Handbook of Automation Computation and Control

EUGENE M GRABBE, SIMON RAMO, AND DEAN E WOOLDRIDGE. *John Wiley & Sons Inc, 440 Fourth Ave, New York 16. 6 x 9, 900 pp.* **$17.**

Purpose of this volume (and of succeeding volumes to be published) is to provide practical design data for feedback control, computer data processing, control computers and control systems.

This first volume is unusually thorough and covers aspects of mathematics not usually available in engineering handbooks. For example, Boolean algebra, probability and statistics.

It attempts to summarize, without lengthy derivations, fundamentals an engineer needs before designing systems. Typical chapters discuss sets and relations (integers, Cartesian products, binary relations), algebra, matrix theory, differential equations, complex variables, transforms, probability, numerical analysis, operations

(Continued on page 138)

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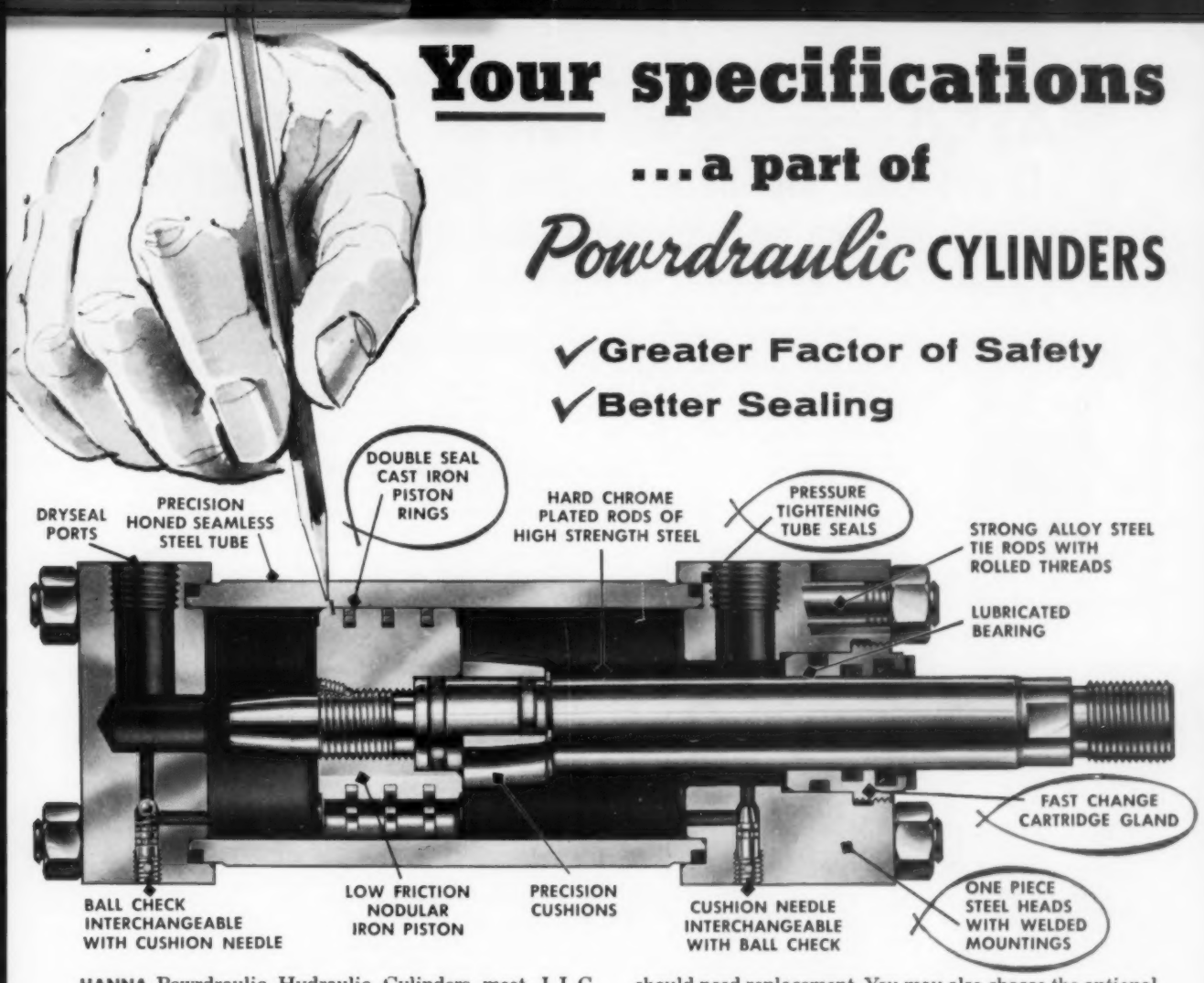
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PRECISION HONED SEAMLESS STEEL TUBE
DOUBLE SEAL CAST IRON PISTON RINGS
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PRESSURE TIGHTENING TUBE SEALS
STRONG ALLOY STEEL TIE RODS WITH ROLLED THREADS
LUBRICATED BEARING
FAST CHANGE CARTRIDGE GLAND
ONE PIECE STEEL HEADS WITH WELDED MOUNTINGS
CUSHION NEEDLE INTERCHANGEABLE WITH BALL CHECK
PRECISION CUSHIONS
LOW FRICTION NODULAR IRON PISTON
BALL CHECK INTERCHANGEABLE WITH CUSHION NEEDLE

HANNA Powrdraulic Hydraulic Cylinders meet J. I. C. recommendations and have industry standard mounting dimensions—2000 psi and 3000 psi non-shock. 1½" through 8" bores.

EXCLUSIVE PRESSURE TIGHTENING TUBE SEALS, located on the outside diameter of the cylinder tube, form a positive seal at all pressures from zero to maximum. Minute expansion of the tube due to pressure, squeezes the "O" ring making the seal even tighter. The "O" ring is fully confined between the head and the tube and will not extrude at high pressures. Unlike other cylinders that seal at the tube ends or inside diameter, the Hanna Powrdraulic Cylinder with pressure tightening O.D. seals will remain tight at all pressures.

DOUBLE SEAL PISTON RINGS give you twice the sealing power of conventional piston rings. These bi-directional, cast iron rings, consisting of a ring within a ring, seal both the "in" stroke and the "out" stroke of the cylinder. The piston with double seal rings is packed for life and never should need replacement. You may also choose the optional piston with "U" type synthetic packings.

FAST CHANGE CARTRIDGE GLAND equipped with a leak proof, low friction rod seal forms a tight seal from zero to maximum pressure. Built in rod wiper removes dirt and particles from piston rod as the rod moves "in" and serves as another hydraulic seal to wipe the rod dry on the "out" stroke. You can select either the standard gland or the optional, multiple lip, spring loaded seal. The optional gland is interchangeable and is available with synthetic rubber or Teflon* Vee packing.

ONE PIECE STEEL HEADS WITH WELDED MOUNTINGS are much stronger than conventional bolted construction and assure squareness of mountings. All mountings are designed to carry maximum cylinder loads with a generous safety margin.

Write for Catalog 900 and the name of your nearest representative.

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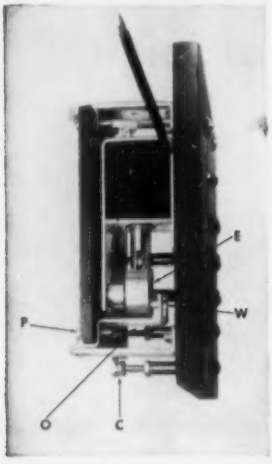
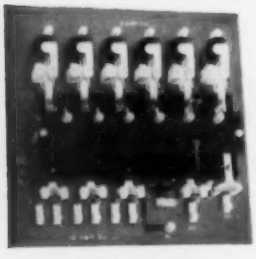


The Unique ASCO Mechanically Held Movement

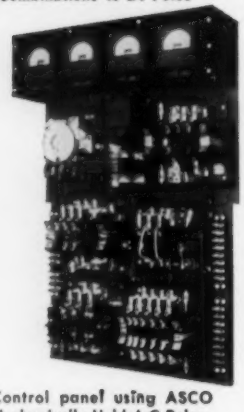
When the solenoid is energized, eccentric cam (E) is rotated. Weight drive pin (W) causes movement of operating lever (O). Lever (O) (connected to the contact finger block) rotates on pivot pin (P) and contacts such as (C) are opened or closed.

Note that with the solenoid de-energized, the entire mechanism is firmly locked in place by the angular position of the linkages—no springs, latches, or semi-permanent magnets are required!

ASCO Mechanically Held Relays A-C and D-C . . . to 25 Amperes Combinations to 24 Poles



Special ASCO Relay with 6 D-C Poles for 600 volts, 3 A-C Poles for 230 volts and 125 volts D-C control. Note Blow-outs on D-C Poles.



Control panel using ASCO Mechanically Held A-C Relays (Bulletin 1256-168). Notice multiple pole and double throw arrangements.

ASCO Power Driven Relays with No Springs or Latches:

- Provide higher contact pressures
- Minimize the possibility of contact welding
- Insure positive operation

Design simplicity is provided in ASCO Mechanically Held Relays through use of a single solenoid coil mechanism. The coil is momentarily energized during the instant of operation only. This momentary surge of power electrically operates the relay to *open and close* contacts; thus the relay is power driven in both directions, with no dependency on springs or gravity for operating and mechanically holding the contacts.

FEATURES

• No A-C hum or chatter • Operate in any position • Compact construction permits mounting on metal surfaces or panelboards • Operated by single-coil mechanism—positive in each direction • Silver contacts rigidly locked open or closed by angular relation of linkages—no delicate hooks or latches • Signal lamps require no extra contacts or control wires • Enclosed rating same as open rating due to liberal design and momentary mechanism without coil losses • All parts finished in cadmium plate or black to present good appearance and to match larger ASCO Switches.

APPLICATION

ASCO Mechanically Held Relays are used for automatic or remote control where A-C hum or chatter is objectionable, where coil loss is undesirable or where relays must not change position when the control circuit fails (low voltage release). ASCO Mechanically Held Relays are often used for master control of other control equipment, to prevent loss of voltage or control failure. These relays are frequently used for electric heaters, lighting, and similar applications.

Mechanically Held Relays are only part of the complete line of Relays made by ASCO. Our Catalog 57-S4 lists:

MAGNETICALLY HELD RELAYS
A-C or D-C . . . Normally Open . . . Normally Closed . . . Double Throw

ASCO Magnetically Held Relays use a physical arrangement which parallels that of ASCO Rocker Type Mechanically Held Relays. Since the two types are similar in appearance, they help to increase the attractiveness of control panels, at the same time offering interchangeability of contacts.

SPECIALIZED RELAYS

. . . Reverse Current
. . . Time Delay
. . . Brake Winding Time Delay
. . . Close Differential
(Voltage and Current Types)
. . . Current Type, Welding
. . . Electronic
. . . Modified Arrangements

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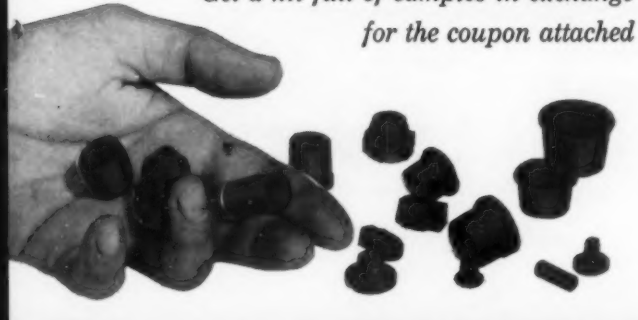

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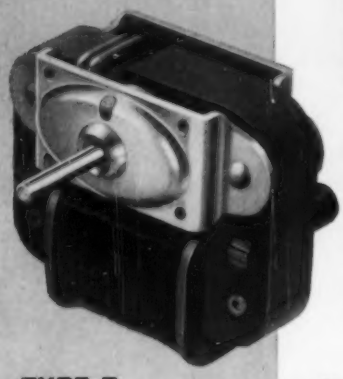
for quiet performance and long life



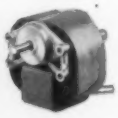
Outstanding for their high starting torque and low-inertia rotors, Barber-Colman motors are first choice for many of the nation's leading manufacturers. Low noise level . . . high dielectric strength coils . . . precision construction . . . compactness . . . long-life lubrication . . . and a quality guarantee backed by 30 years' experience are among the many other features of these motors that will assure long, trouble-free service in your product.

TYPE B

A high-quality motor at low cost that gives you a strong competitive advantage. Power output and starting torque exceptionally high in relation to size. Other "plus" features include alignable bearings . . . long-life lubrication . . . auxiliary oil cups . . . hardened and ground stainless steel shafts . . . ratings up to 1/200 hp.

TYPE A Ideal for use in cramped quarters. Smallest unidirectional core-type motor in the line, yet has good starting torque and power output

TYPE F Features extra high power to weight ratio while maintaining exceptionally good starting torque. Porous bronze bearings, large oil wicks.



TYPE R High-torque Barber-Colman motor for heavier power requirements up to 1/20 hp. Heavy-duty construction for the most exacting applications.

Open and enclosed geared types

for longer life at lower cost

TYPE DZ

TYPE HZ

TYPE PZ

For longest life per dollar invested put Barber-Colman geared motors into your product. High-quality construction throughout . . . accurately hobbed gears, all of which are of properly heat-treated steel (except first step Textolite gear for quieter performance) high torque, positive starting.

TYPE DZ — Open-type, double-gear plate motors for applications requiring a rugged, long-life motor. Designed to handle overhanging loads. Available in unidirectional, reversible, and synchronous models.

TYPE HZ — Low-cost, rugged, compact, high-torque motors available in unidirectional, reversible, and synchronous models.

TYPE PZ — Enclosed geared construction for mounting externally to driven device. Unidirectional, synchronous, and reversible models.

FREE CATALOG HELPS SELECT MOTOR NEEDED

Get the helpful condensed catalog of Barber-Colman shaded pole small motors. Contains complete descriptions of above motors, shows typical specifications, performance characteristics, control circuit diagrams. Write for your copy.

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research, coding, data transmission, feedback control (includes translation and transfer equations with schematics of typical systems), stability (including Nyquist, Bode and other analyses), transients, frequency response, nonlinear systems and sample data systems.

About half the book is devoted to feedback control and the problems encountered. Enough curves, illustrations, tables and schematics are given to make the book complete within itself—at least to a person already somewhat familiar with the field.

Experiments on Vigilance One-clock and Three-clock Monitoring

HARRY J JERISON *PB 131191, Available from Office of Technical Services, Washington, D.C. 8½ x 11, 40 pp. $1.*

Two experiments on prolonged monitoring of Mackworth-type clocks are reported. In one experiment with thirty-six subjects, a single clock was monitored. It was found that performance dropped from about 90% of the signals found to about 50% during the first half hour of work, and that performance drop appeared to be continuous. In a second experiment, 11 subjects each monitored a panel of three clocks. Their performance curve appeared to be flat, but it seems likely that a rapid decrement from the 45% to the 27% level occurred during the present state of knowledge about the human operator as a monitor and in terms of recommendations that have been made in the past concerning limitations of length of watches for monitors in order to maintain their efficiency. A brief summary and conclusions section is included. The report is the second in a series.

Theoretical and Experimental Analysis of Members Loaded Eccentrically and Inelastically

OMAR M SIDEBOTTOM AND MARLYN E CLARK. *University of Illinois, Engineering Publications Office, 114 Civil Engineering Hall, Urbana, Ill. 8 x 11, 48 pp. $1.*

Current engineering design calls for increased material use to save weight and bulk. A recent method, which has been used to increase strength-weight ratio, considers, in the

(Continued on page 139)

design procedures, the inelastic load-carrying qualities of members. General purpose of the investigation covered in this bulletin was to determine analytically and experimentally the effects of small amounts of inelastic action on the load-carrying capacity and deformational behavior of members subjected to either eccentric tensile or compressive loads.

Dynamic Corrosion In Polyphenyls Under Irradiation

Report NAA-SR-2046. Available from Office of Technical Services, Dept of Commerce, Washington 25, DC. Paperbound, 8½ x 11, 29 pp, $1.

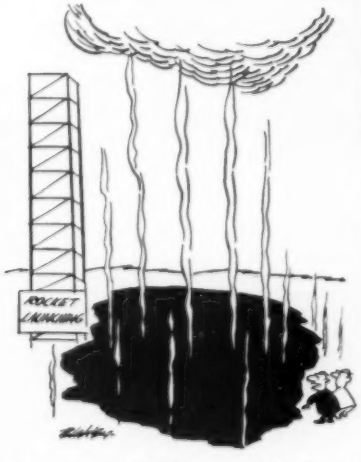
Some metallic materials corrode badly when exposed to irradiated polyphenyls—notably magnesium and zirconium. Aluminum and certain varieties of steel, on the other hand, show good resistance, making them suitable for organic moderated and cooled reactors. Report includes charts, drawings and photographs.

Engineering Consultants

American Institute of Consulting Engineers Inc, Suite 401, 33 W 39th St, New York 18. 5¾ x 7¾, 136 pp. $2.

By far the greatest portion of practicing consultants are civil engineers or those working in allied fields. The fact is supported by consultants listed in this directory. But some mechanical engineers, chemical engineers, instrumentation and control experts. Com-

(Continued on page 141)



"Someone goofed—it was upside down."

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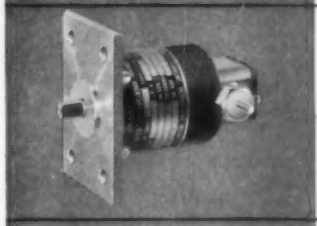
Small, high-quality d-c motors for industrial equipment and aircraft control applications. Output up to 1/10 hp . . . permanent magnet and split series types . . . various mountings and speeds. Offered with gearheads or blowers. Radio noise filters available.

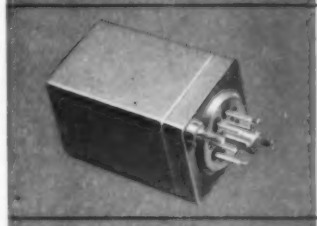
a-c 400 cycle motors

Precision missile and aircraft a-c motors designed to MIL-M-7969a. The capacitor type, four-pole motor features a balanced winding permitting reversal with an SPDT switch. A 400-cycle brake is available. Typical rating is .020 horsepower at 9700 rpm and 83 watts input, intermittent duty.



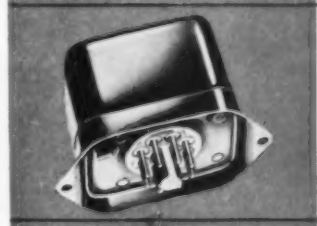
tach generators

For accurate speed indication and servo rate control applications. Supply up to 40 volts per 1,000 rpm within plus or minus 0.5% linearity. Standard temperature range is −65° to +200°F, but units have been made for −65° to +500°F ambient.



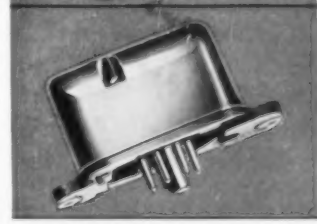
polarized d-c relays

Ultra-sensitive polarized d-c relays capable of operating on input powers *as low as 40* microwatts. Available with three types of adjustment: null-seeking . . . symmetrical magnetic-latching . . . or conventional form C snap-acting. Can also be supplied with integral transistor preamplifiers.



choppers

Feature extremely low driving power . . . low noise level . . . excellent stability . . . long contact life. Convert a low-level d-c signal into a low-level a-c signal which can be amplified to operate control apparatus. Can also be used as a synchronous rectifier to convert low-level a-c signals to d-c without loss.



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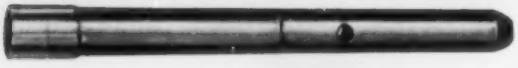

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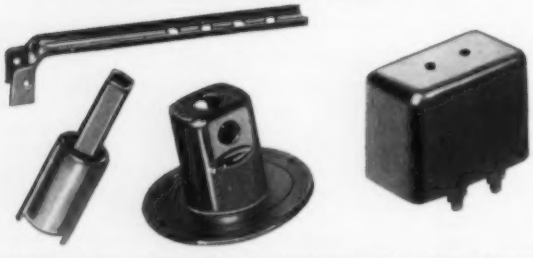

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munications experts are also included. Directory records name, address, field of specialty, affiliation with consulting firm, and personal data for each consultant. Book is organized in three parts: directory of consultants; directory of consulting firms; and cross-reference grouped by location and field of specialty.

Short Dictionary of Mathematics

C H McDOWELL. Philosophical Library Inc, 15 E 40th St, New York 16. 63 pp, 4¾ x 7½. $2.75.

All mathematical terms in common use—in arithmetic, algebra, geometry and trigonometry—are explained in language that makes them generally intelligible.

Knurling

American Standard B5.30-1958. ASME, 29 W 39th St, New York 18. Paperbound, 8½ x 11, 15 pp. $1.50.

This revised edition of Standard B5.30, published in 1953, includes data on tooth depths for diagonal knurls and some editorial changes for the sake of clarity. As in the past, Standard specifies dimensional relationships between tool and stock and gives standard diametral pitches for tools.

Bibliographic Survey of Corrosion, 1954-55

Publication No 58-1, National Assn of Corrosion Engineers, 1061 M & M Building, Houston 2, Texas. 8½ x 11, 468 pp. Non-members, $20; members, $15.

A selection of 4287 abstracts of articles on corrosion and corrosion prevention published in 1954-55 are compiled in this volume. Also included are a number of abstracts published from 1945 to 1953 which were not available for use in earlier bibliographies. Material was selected from abstracts compiled by 23 agencies covering literature internationally.

Tapping Screws

American Standard ASA B18.6.4-1958. ASME, 29 W 39th St, New York 18. Paperbound, 8½ x 11, 143 pp. $4.

Sheet-metal screws, self-tapping screws, lag screws—the family name for these, and many other special-purpose thread types, is "tapping screws." Included herein are American Stand-

(Continued on page 145)

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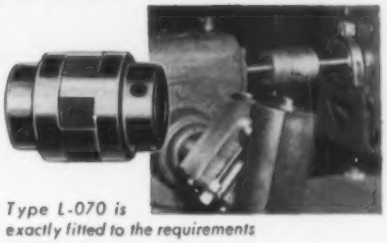

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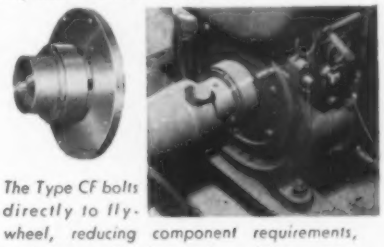

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These features have been used to advantage in airframe structural members, airframe skins, pressure tanks, power plant components, high pressure ducting, nacelles and other missile and supersonic aircraft applications.

availability: AM350, introduced several years ago, is available commercially in sheet, strip, foil, small bars and wire. AM355, best suited for heavier sections, is available commercially in forgings, forging billets, plates, bars and wire.

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For further information, see your A-L sales engineer or write for the booklet "Engineering Properties, AM350 and AM355." *Allegheny Ludlum Steel Corporation, Oliver Building, Pittsburgh 22, Pa.* Address Dept. PE-13.

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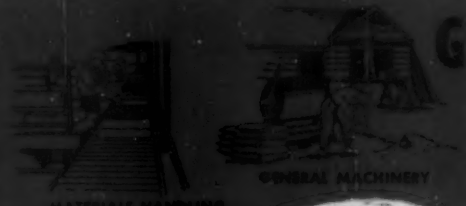

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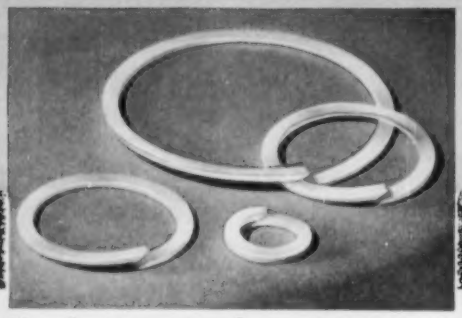

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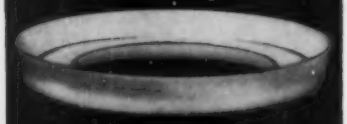

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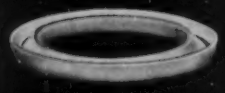
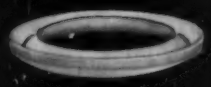
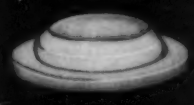


Style 614 V Rings



Style 410 U Cups and Blocked Vees



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ards for dimensions, tolerances, materials, head type for all varieties of thread cutting and thread forming screws.

Handbook of Chemistry and Physics—40th Edition

Chemical Rubber Publishing Co, 2340 Superior Ave NE, Cleveland. 345 pp, 5¼ x 7⅜. $12.

This handbook includes material on chemistry, physics, mathematics and other allied sciences. Added to this edition are tables pertaining to electron physics, rare earth compounds, inorganic hydrides, moisture content, thermodynamic properties, chelating agents, ion exchange resins and other topics. Much of the information in former editions has been brought up to date.

Eiectronic Components Handbook–Vol. 2

KEITH HENNEY AND CRAIG WALSH. *McGraw-Hill Book Co Inc, 330 W 42nd St, New York 36. 8½ x 11, 368 pp. $12.50.*

This volume concentrates (as did Vol I) on those component parts for which military and industrial specifications have been written–they can be bought and used without getting special permission from the military services.

The components described are power sources and converters, fuses and circuit breakers, electrical indicating instruments, printed wiring boards, solder and flux, choppers,

(Continued on page 147)

"Stop . . . Hold it . . .! There's a change in design . . . it's to be a running instead of a press fit . . ."

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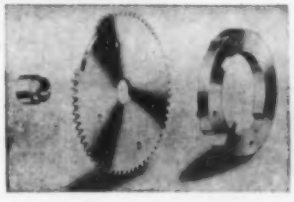
Compare the methods for producing these mutilated gear, cam and bushing combinations . . . for an electrical appliance timer. (Shown actual size)

*method A

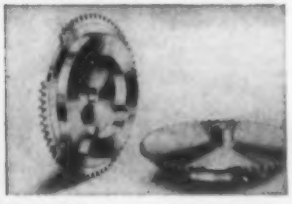


*Stamping, screw machine part, assembly

- Blanked, pierced, & extruded Cam
- Blanked & pierced Gear
- Screw Machined Bushing
- Sub-assembly: Stake Bushing to Gear
- Final Assembly: Stake Cam to Gear

5 PRODUCTION STEPS + 5 Inspections

the GRC method



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Survey of Ferroelectrics at High Temperatures

CHARLES F PULVARI. *Available from Office of Technical Services, Dept of Commerce, Washington 25, DC. Paperbound, 8½ x 11, 68 pp. $2.*

This document compiles the work of many investigators pertaining to high temperature properties of ferroelectrics. Plots of data show temperature dependence of such properties as crystal structure and dielectric constant for some 25 ferroelectric materials.

Tooling for Metal Powder Parts

GEORGE H DeGROAT. *McGraw-Hill Book Co, 330 W 42nd St, New York 36. 6¼ x 9¼, 242 pp. $7.50.*

This reference book emphasizes the production of structural parts. Material is included on part design, production of powders, briquetting techniques and tools, sintering, finishing processes.

Numerical Control Systems for Machine Tools

Proceedings of the EIA Symposium, Engineering Publishers, Div AC Book Co, Inc, GPO Box 1151, New York 1. 8½ x 11, 106 pp. $5.

This paperback report contains the full text of 15 technical papers describing design and application of numerical control, plus a keynote address by Lt Gen C. S. Irvine, USAF. Definitions and simple block diagrams are provided as well as sketches of numerical systems and machine tools. There are also specific descriptions of the Numericord, Digimatic, Bendix, General Electric, Univac, and Cincinnati systems.

Fluorocarbons

MERRITT A RUDNER. *Reinhold Plastics Applications Series. Reinhold Publishing Corp, 430 Park Ave, New York 22. 5¼ x 7½, 238 pp. $5.75.*

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(Continued on page 149)

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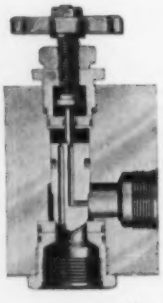

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Electronic Circuits

E J ANGELO JR. *McGraw-Hill Book Co Inc, 330 W 42nd St, New York 36. 6 x 9, 450 pp. $9.*

This text steers clear of case-history circuits and devotes itself exclusively to basic circuits applicable to all types of vacuum and solid state designs. It follows a premise that most electronic circuits can be characterized by the familiar R's, L's, and C's plus two additional elements, the ideal diode and the ideal controlled source.

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Glass Engineering Handbook

F B SHAND. *McGraw-Hill Book Co Inc, 330 W 42nd St, New York 36. 6¼ x 9¼, 484 pp. $10.*

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(Continued on page 150)

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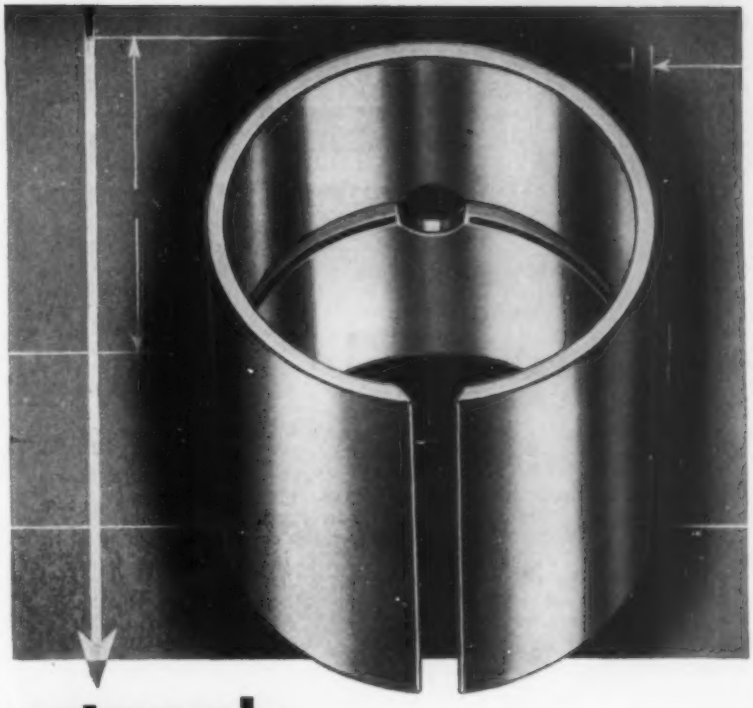

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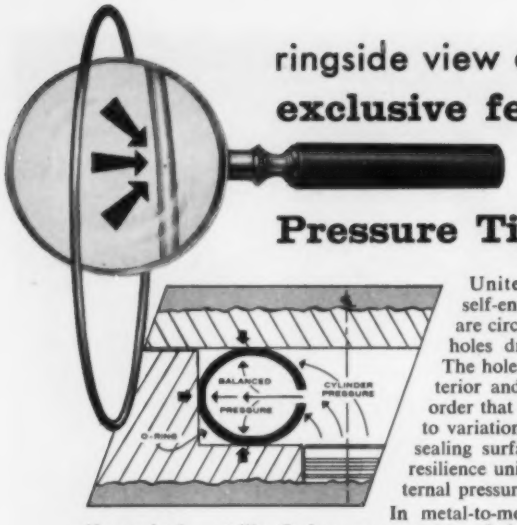

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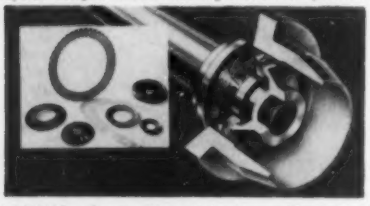

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Induction Motors—Single Phase & Polyphase

CHARLES S SISKIND. *McGraw-Hill Book Co Inc, 330 W 42nd St, New York 36. 6 x 9, 390 pp. $7.50.*

Written with a minimum of mathematics, this book provides broad coverage—principles, standards of operation, applications, control and design—of single-phase and polyphase motors. Illustrations are neat and to the point.

The motor control section covers manual and automatic operations such as acceleration, braking, jogging, speed control, and sequencing. Unusual motor control types are explained, such as Schrage (brush-shift), Kraemer, Rossman and eddy-current.

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Transform Method in Linear System Analysis

JOHN A ASELTINE. *McGraw-Hill Book Co, 330 W 42nd St, New York 36. 6¼ x 9¼, 300 pp. $8.50.*

Transforms are a valuable mathematical tool, but the practical value is perhaps too often clouded by rigorous mathematics. This book is for engineers and the emphasis is on application of the transform methods to engineering problems—mathematics are presented from the engineer's rather relaxed point of view regarding rigor. Considerable space is devoted to the concepts of system function, frequency response, impulse response.

(Continued on page 151)

Application of block diagrams, steady-state behavior, weighting functions, convolution integrals and impulse response are described in detail. Included are examples and over 150 typical problems.

Vinyl Resins

W MAYO SMITH. *Reinhold Plastics Applications Series. Reinhold Publishing Corp, 430 Park Ave, New York 22. 5¼ x 7½, 282 pp. $5.75.*

The vinyls are at present the most versatile and largest selling family of plastics–and their popularity is growing fast. This handy volume thoroughly surveys applications for vinyl resins, with introductory information on their types, properties, chemistry, manufacture and fabrication. Latest members of the family–PVC "pearls" and Delrin resin–are included.

Current Reprints

While the supply lasts, single copies of the following reprints are obtainable by using the Reader Service Card.

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Applications and costs charted for a simpler way to pin down the right electric motor. Jan 19 *Circle E 61*

With What Do the Russians Weld?

Latest Soviet techniques—electro-slag, submerged-arc, and stored-energy welders. Jan 19 *Circle E 60*

Engineer Salary Surveys

Engineers Joint Council says engineer salaries are up 13% since 1956. GE reports effect of higher living costs. Jan 5 *Circle E 59*

Mixed-flow Impellers

When air pressure requirements are too high for axial and too low for centrifugal fans. Jan 5 *Circle E 58*

Carpet Plotting for Hi-temp Data

Data sheet shows interaction of stress, strain and temperature. Jan 5 *Circle E 57*

Gear Standards

Proposed all-inclusive standard for spur and helical, for both instrument and power service. Dec 22 '58 *Circle E 56*

Foreign Patents

Why get them? Six steps to follow for profitable licensing. Dec 15 '58 *Circle E 55*

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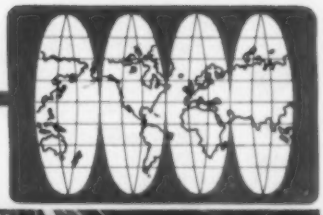

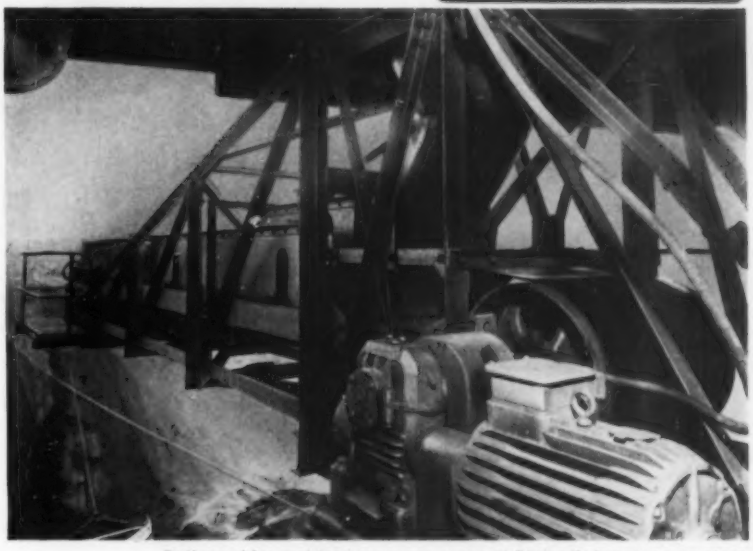

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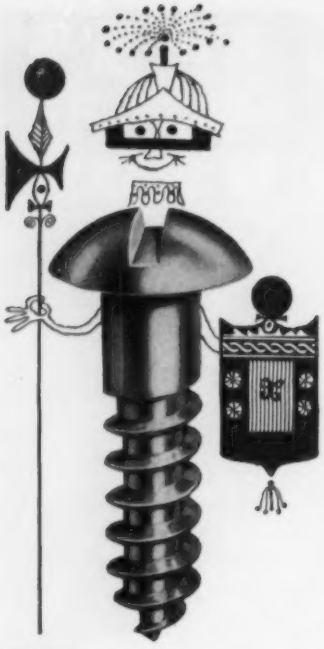

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Porcelain Enamel
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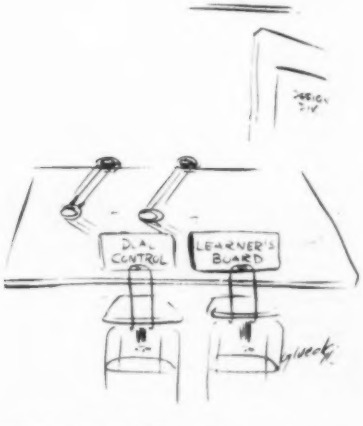

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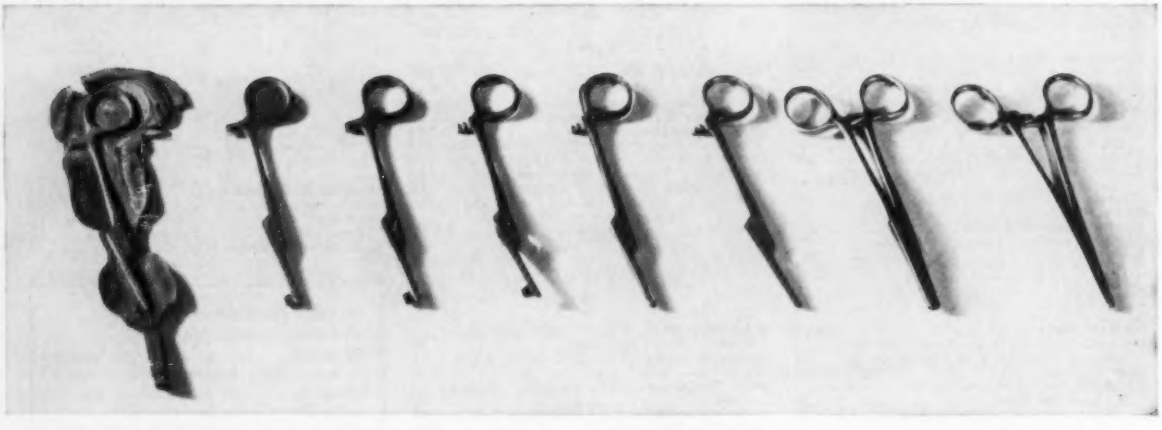

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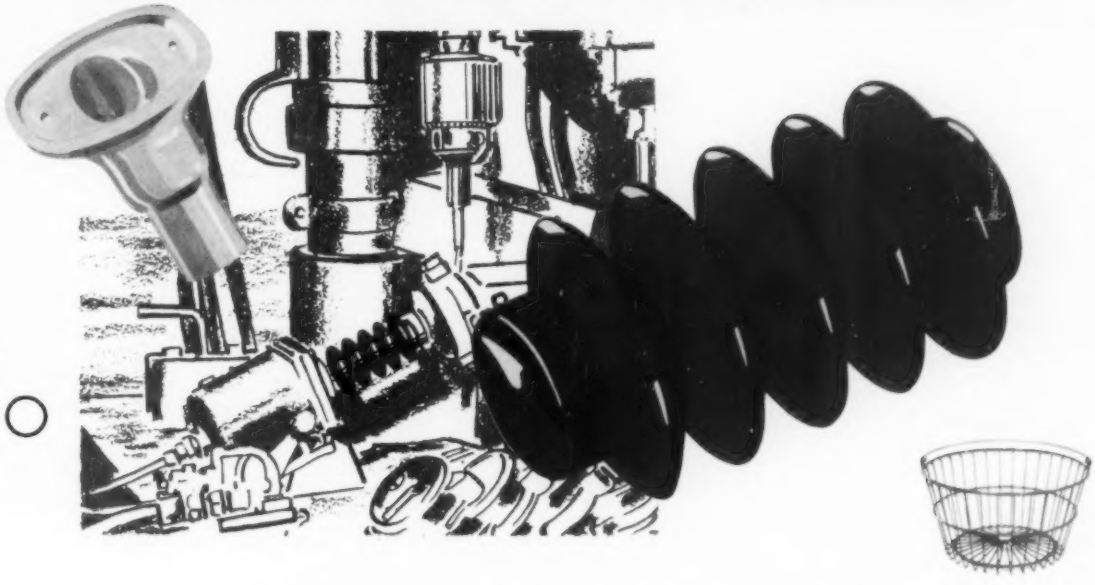

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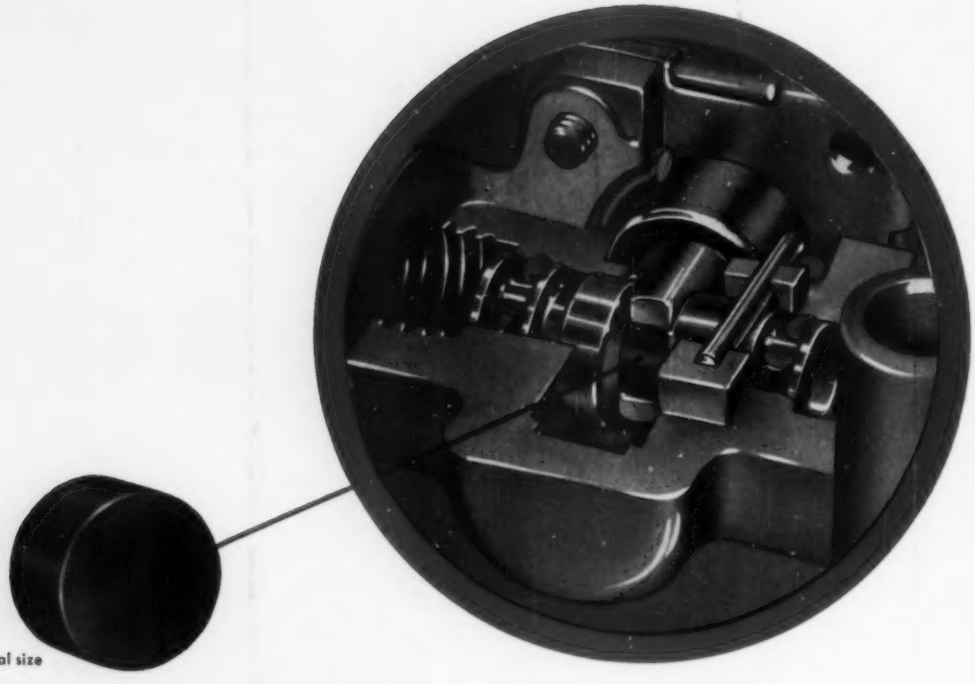

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